THEORY AND ANALYSIS OF THERMALLY STIMULATED DISCHARGE CURRENTS IN ICE

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TABLE OF CONTENTS

ABSTRACT

Thermally-stimulated discharge current data, in the temperature range of 90 to 230 deg.K, was collected for 18 ice samples which were frozen and refrozen, under atmospheric conditions, an 11 PSI vacuum and under pressurized carbon dioxide gas. Both stainless steel and stainless steel with teflon blocking layers were used for electrodes. This data was collected for purposes of explaining what polarization mechanisms produce the observed thermally-stimulated discharge (TSD) current peaks in ice.

Three TSD peaks were observed at temperatures of 109.8, 136.3 deg.K and a third in the temperature range of 218 to 230 deg.K. In addition to these peaks continuous heterocharge and homocharge currents were observed mostly between the second and third peaks.

The results indicate that the coldest peak is probably caused by the reorientation of L and D defect dipoles. Good estimates of this peak's parameters are $E=.601 \times 10^{4}$ cal/mole and $\tau_o=.234 \times 10^{-9}$ sec. A second 136.3 deg.K peak may be caused by L or D defects being trapped by gas impurities. Poor estimates of this peak's parameters are $E=.532 \times 10^{4}$ cal/mole and $\tau_o=.204 \times 10^{-7}$ sec. A third peak which occurs between 218 and 230 deg.K may have H_3O^+ as one of its polarization mechanisms. This peak is so inconsistent and broad that it probably has many polarization mechanisms responsible for it.

1-INTRODUCTION

An electret is a dielectric which is capable of maintaining a persistent electric field, analogous to a magnet, which supports a persistent magnetic field. Ice is an interesting example of an electret because it has a simple structure yet exhibits a variety of charge storing mechanisms. These mechanisms are observed by first slowly cooling the ice under the influence of an electric field. "Since internal friction depends exponentially on temperature, the response time of permanent dipoles and free charges changes markedly with temperature."[1] Below a critical temperature the polarization becomes semi-permanently frozen in, which makes ice an electret. Now if the polarized ice is heated, to release this frozen-in polarization, a current can be measured. Such a current is called a thermally-stimulated-discharge (TSD) current.

This work is concerned with applying the TSD method to ice, to gain an understanding of its dielectric behavior. The TSD method is very useful because it produces a continuous current spectrum, with each polarization mechanism ideally yielding a separate current peak. Hopefully this work will reveal what polarization mechanism is responsible for each current peak and what parameters describe those peaks. Specifically an activation energy (E), pre-exponential factor (Υ_o) and maximum polarization strength (P_o) should be assigned to each peak.

Unfortunately the TSD response of ice has been difficult to explain for many reasons. One reason is that the TSD response may be very sensitive to the purity of water used to make the ice.

Thus different investigators report varying numbers of peaks at varying temperatures. TSD peaks of ice also strongly overlap and thus make it difficult to accurately determine peak parameters. This makes any efforts, of comparing peak parameters with theoretical polarization mechanisms, very questionable. Moreover; there is confusion over what polarization mechanisms may actually be present in ice, as a review of the literature should illustrate.

Johari and Jones (2) collected TSD data, on both H_2O and D_2O ice, to determine whether the occurrence of TSD peaks is caused by a relaxation process or a thermodynamic phase transformation. They discovered peaks in H_2O ice at 110, 159 and 233 deg.K, and in D_2O ice at 124, 163 and 227 deg.K. This was with a heating rate of .0023 deg.K/sec. Since the first two D_2O ice peaks occured at warmer temperatures than the first two H_2O ice peaks, they concluded that a relaxation process must be present. To further substantiate this conclusion they noticed that the temperature at which TSD peaks appear increases with increasing heating rate. With heating rates of 2.28×10^{-3}, 1.84×10^{-2}, 2.65×10^{-2} and 4.5×10^{-2} deg.K/sec the first peak temperature was 110, 114, 123 and 132.5 deg.K. Johari and Jones measured an E=11.3 kcal/mole, $\tau_o = 5 \times 10^{-20}$ sec. and an equilibrium dielectric permittivity (ε_s) of 233 +/- 10 at 120 deg.K. On the basis of the magnitude of ε_s they concluded that H_2O ice does not undergo a proton ordering to a ferro- or anti-ferroelectric phase at temperatures as low as 98 deg.K.

Pissis, Apekis and Boudouris (3) looked at the effect of water conductivity on the TSD spectrum in ice. Like Johari and Jones, Pissis et. al. saw three TSD peaks occuring at 125, 160 and 225 deg.K. They found that the 125 deg.K. peak was independent of water purity based on the independence of peak temperature, E and τ_o from water purity. They also attributed the 125 deg.K peak to orientational polarization of water molecules based on the following reasons:

1) The amplitude of the peak was proportional to the applied electric field.
2) The peak temperature was independent of both polarizing field and polarizing temperature.
3) An activation energy could be calculated, in agreement with dipolar-reorientation theory.

They also concluded that the 125 deg.K peak was independent of the concentration of extrinsic physical defects.

Conversely, Chamberlain and Fletcher (4) studied the effects of HF concentration on the ice TSD spectrum and noticed that the peak temperature, of the 100 deg.K. peak, increased as the HF concentration was decreased. The magnitude of this peak was constant over the HF concentration range of 10^{20} to 10^{25} m^{-3}. They further concluded that the 100 deg.K. peak was probably caused by oriented dipoles whose relaxation times were governed by the L-defect concentration which was determined by the HF concentration. A second peak also occurred randomly over the temperature range from 125 to 135 deg.K and was observed in pure ice specimens too.

Dengel, Eckener, Plitz and Riehl (5) reported on the possibility that ice is ferroelectric at temperatures around 100 deg.K. Their measurements showed a sharp increase in the dielectric constant around

100 deg.K, which they take to be the curiepoint. However their findings were based on a charging current peak that occured when a field of 400 V/cm was applied to the ice. "A true ferroelectric crystal is defined as a crystal which exhibits a spontaneous electric dipole moment; in other words, a crystal for which even in the absence of an applied electric field the center of positive charge does not coincide with the center of negative charge."[6] Thus they are not really talking about ferroelectric behavior. In addition they mentioned that ferroelectric behavior could only be observed if the water was not extremely pure.

Mascarenhas and Arguello (7) studied the effect of HF doping on ice TSD currents, in the temperature range of 173 to 253 deg.K. They observed a peak at approximately 223 deg.K. with the total charge released varying as the square root of the HF concentration. This indicated that OH^- and H_3O^+ ions were responsible for the peak. Space charge formation was also shown to be associated with the electret behavior.

Previous works conducted in this laboratory, using the flat-disk sample holder, found three peaks in ice in the temperature range from 110 to 180 deg.K.[8] The peak temperatures were reported as 125, 140 and 155 deg.K with activation energies of 7.21, 8.24 and 9.89 kcal/mole respectively. The pre-exponential factors were 35×10^{-12}, 5×10^{-12} and 0.1×10^{-12} sec. with a heating rate of 0.044 deg.K/sec. The coldest peak was consistently stronger than the other two peaks and thought to be the result of dipole orientation. The middle peak was quite irregular and felt to be the result of extrinsic defects. The warmest peak, appearing with great consistency, was thought to be the result of small impurity concentrations on the dipolar relaxation process.

To summarize these findings, it is clear that three or more TSD peaks are present in ice, in the temperature range of 100 deg.K to 235 deg.K. These peaks are not consistent in magnitude or in peak temperature between different investigators. People have concluded that the coldest peak is either a ferroelectric response or more likely a dipole response due to reorientation of D and L defects. There are no strong conclusions about the second peak and the third peak may partly be caused by space charge induced mainly by the migration of H_3O^+ defects.

2-APPARATUS AND METHOD

The electrical measurement circuit is shown in figure 1. The ammeter is a Keithley Model 410A Picoammeter with an accuracy of +/- 4% of full scale on 3×10^{-9} to 3×10^{-13} ampere ranges, with a maximum rise time, for 90% of the current, of 0.1 to 2.5 seconds over those ranges. The voltage source is a Fluke Model 412A DC supply and has a range of 500 to 2000 volts. A Honeywell Electronik 195 strip chart recorder is used to continuously record the discharge current and the sample temperature, which is measured with a copper-constantan thermocouple. The recorded current and temperature are estimated to be within +/- 3% and +/- 1.5 deg.K respectively. A linear heating rate is controlled by a Love Model 52 proportional controller with programmed heating rates of 0.044 deg.K/sec. and lower. Heat is supplied by two 100 watt Fast Heat heating cartridges in the sample holder and a 7.3 ohm Nichrome heating coil wrapped around the aluminum block. One problem to watch out for is that the heating

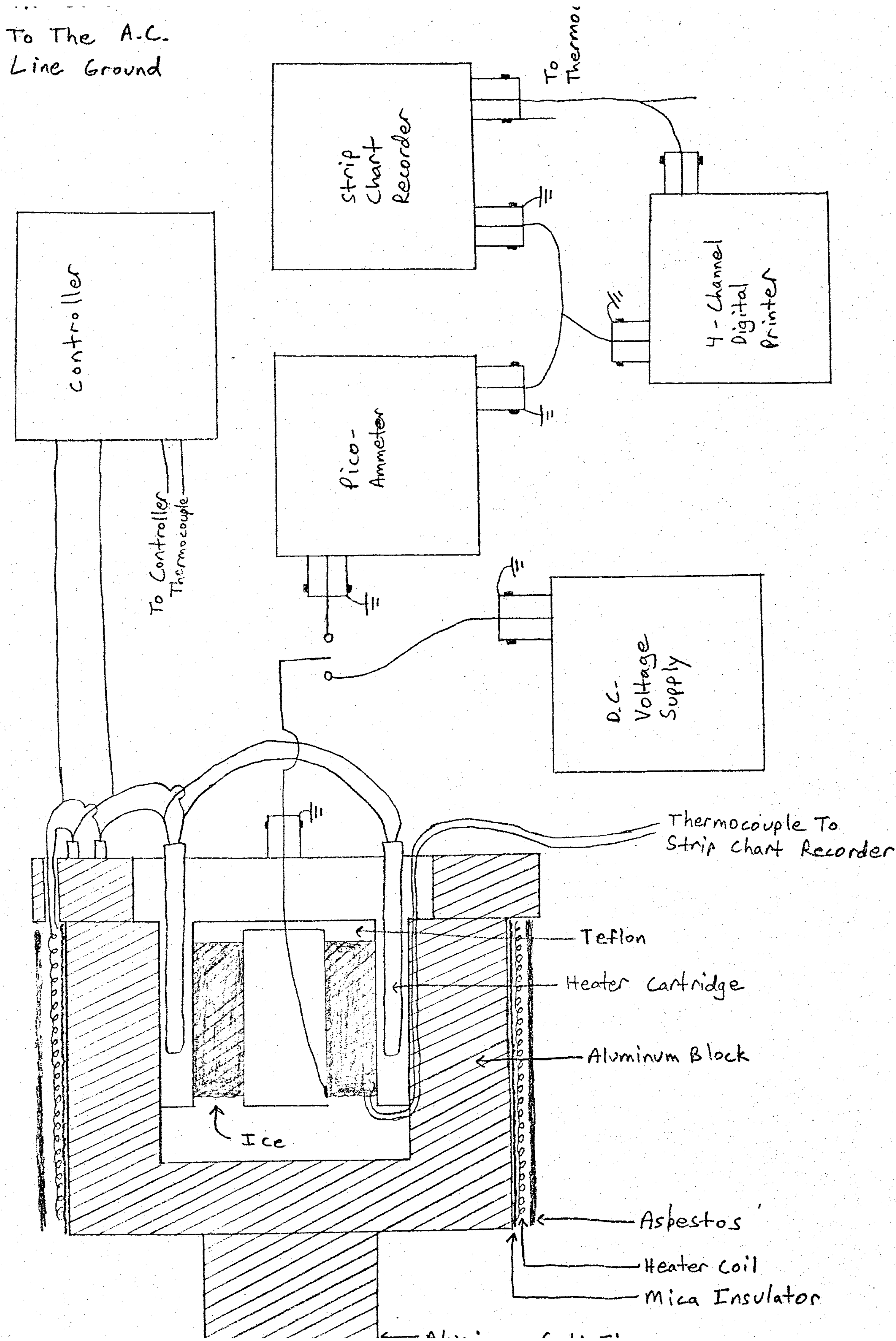

To The A.C.
Line Ground
Controller
Strip Chart Recorder
4 - Channel Digital Printer
Pico-Ammeter
D.C. Voltage Supply
To Controller Thermocouple
Thermocouple To Strip Chart Recorder
Teflon
Heater Cartridge
Aluminum Block
Ice
Asbestos
Heater Coil
Mica Insulator

FIG. 1

coil is insulated from the aluminum block by several mica sheets and some fiberglass tubes. If this insulation breaks down then the heater pulses produce electrical noise in the ammeter output. This noise is very distinctive and easily distinguishable from the normal bumpy current line. Both the aluminum block and the sample holder are inside a stainless-steel cryogenic container, cooled by liquid nitrogen.

Also available, but not used for this study, is a Gultan ANP-9 four channel digital printer which prints out the thermocouple EMF versus current data at an adjustable time interval. Due to the bumpy nature of the concentric-cylinder sample holder data it was thought that a digital printout of the TSD data would be impractical. The printer is useful for the smooth data that the flat-disk sample holder gives. It should be noted that the printer scans the four channels for data. If it finds no data on the first channel it won't look at the other three.

Two sample holders are used; one has two parallel copper-disk electrodes and the other has two concentric stainless-steel cylindrical electrodes. Refer to figure 2 for diagrams of the sample cells. The concentric-cylinder sample holder has two stainless-steel cylinders with a 0.37 inch space between them. Ice is grown in the gap using a procedure described below. A copper-constantan thermocouple frozen into the ice monitors the ice temperature during TSD measurements. Negligible vertical and radial temperature gradients are measured with a heating rate of 0.019 deg.K/sec. Two teflon cylinders (.0035 inches thick) are sometimes included as

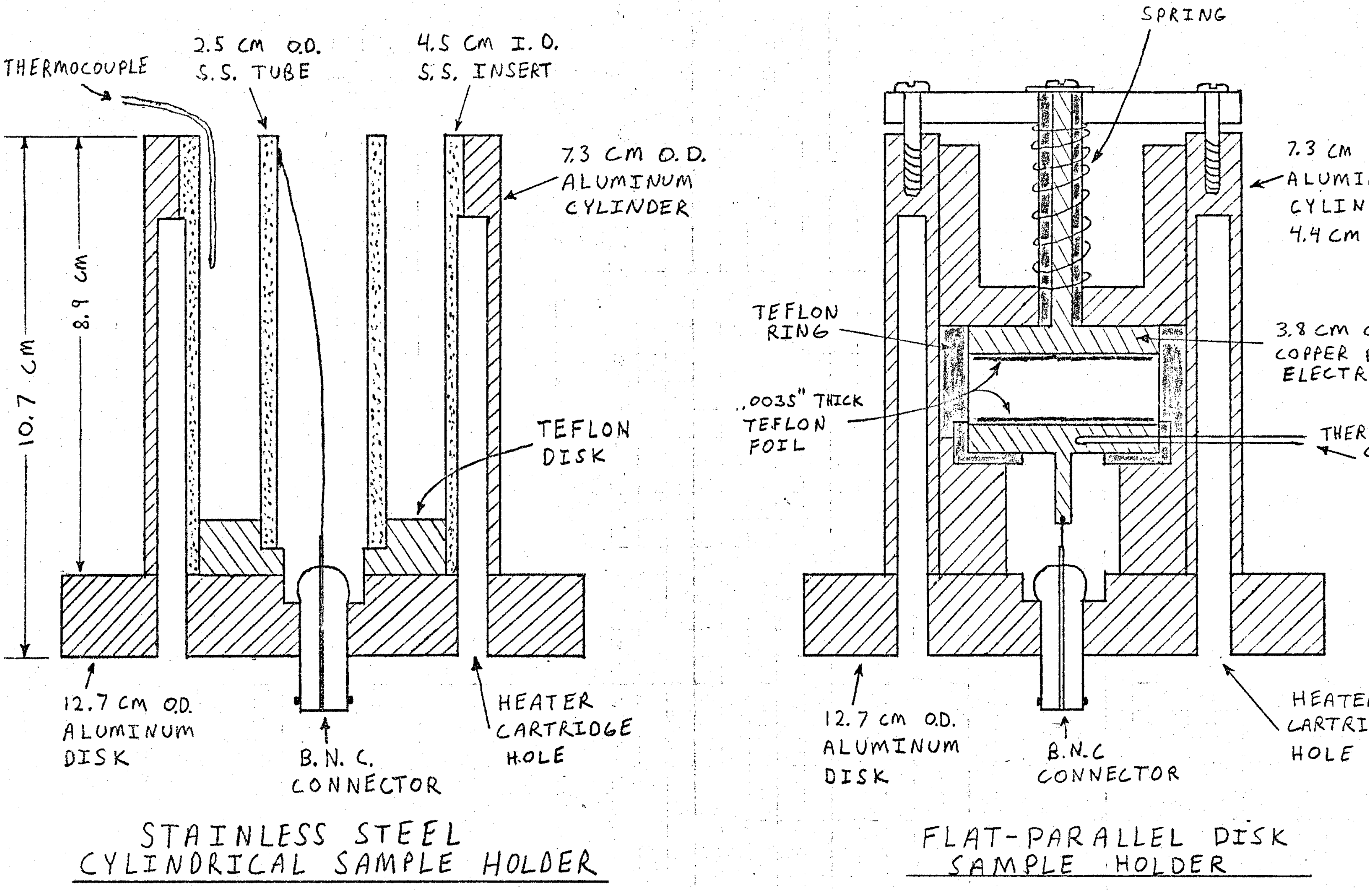
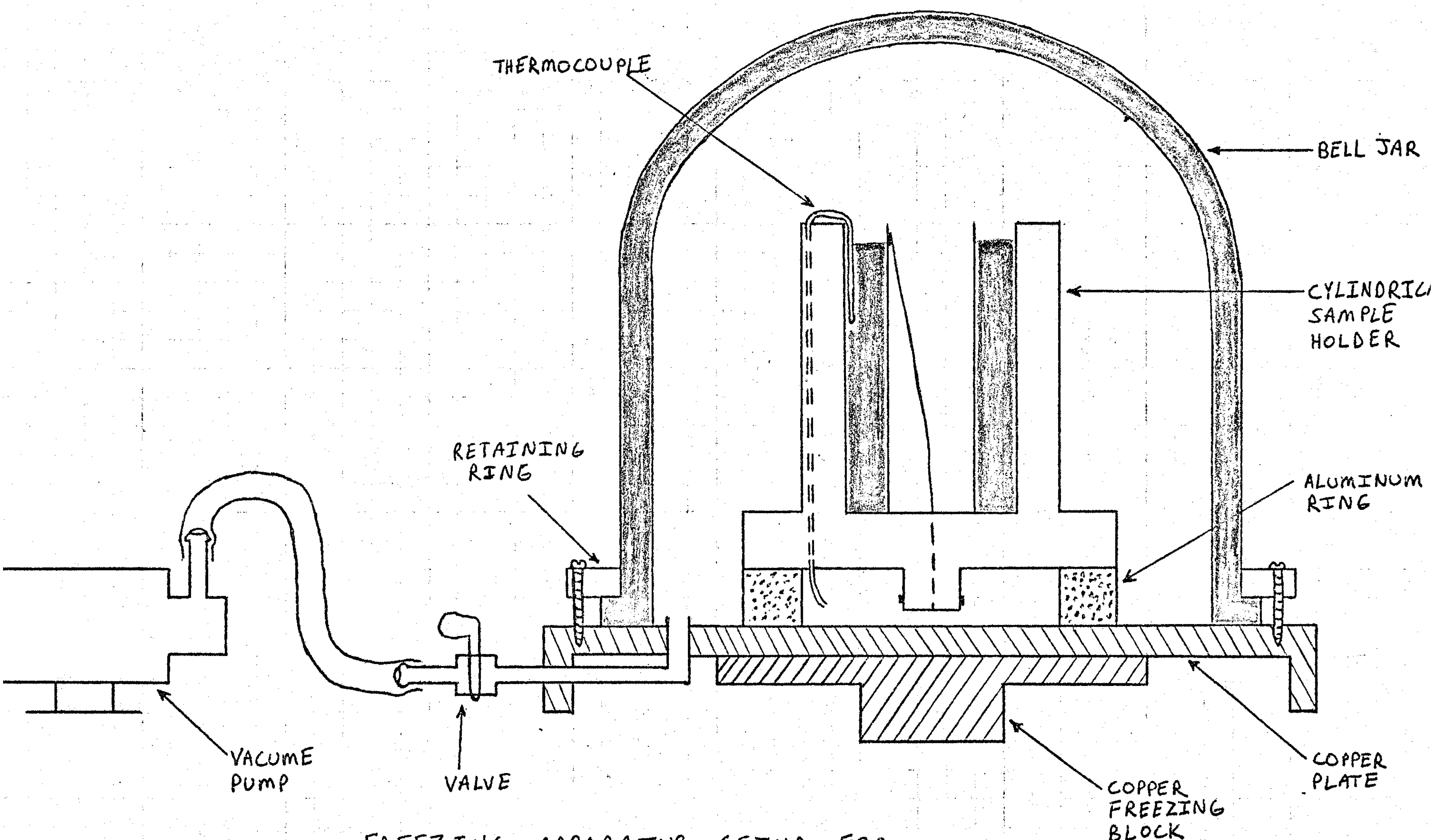

THERMOCOUPLE
2.5 CM O.D.
S.S. TUBE
4.5 CM I.D.
S.S. INSERT
7.3 CM O.D.
ALUMINUM
CYLINDER
10.7 CM
8.9 CM
TEFLON
DISK
12.7 CM O.D.
ALUMINUM
DISK
B.N.C.
CONNECTOR
HEATER
CARTRIDGE
HOLE
STAINLESS STEEL
CYLINDRICAL SAMPLE HOLDER
SPRING
7.3 CM
4.4 CM
TEFLON
RING
.0035" THICK
TEFLON
FOIL
12.7 CM O.D.
ALUMINUM
DISK
B.N.C
CONNECTOR
FLAT-PARALLEL DISK
SAMPLE HOLDER

FIG. 2

blocking layers. The empty cell has a capacitance of 14.1 picofarads without teflon blocking layers and 15.7 picofarads with teflon blocking layers.

The apparatus used for growing the ice in the concentric-cylinder sample holder is shown in figure 3. After thoroughly washing the sample holder and thermocouple with distilled water, the sample holder is filled with distilled water (resistivity of approximately 1×10^6 ohm-cm). The sample holder is then placed under a bell jar on the copper freezing block. The bell jar is screwed down onto a copper plate so that the ice can be frozen under a variety of pressures. Mostly a vacuum of 11 PSI is applied during freezing to try and degas the water; however, freezing under a pressure of CO_2 is also tried. The CO_2 source is dry ice that is placed under the bell jar before it is screwed down. The dry ice lasts for about 45 minutes and maintains a pressure of approximately 7 PSI before it is gone. When the pressure starts to drop the valve to the bell jar is closed. The freezing apparatus gives much freedom to change the atmospheric conditions over the water but allows little control of the freezing rate. For refreezing, the ice sample is placed in the bell jar apparatus and allowed to melt at room temperature under an 11 PSI vacuum. After melting the freezing procedure is repeated.

The flat-disk sample holder has copper-disk electrodes with Teflon disks (.0035 inches thick) used as blocking layers. The electrode separation can be adjusted, but with an air gap of 0.37 inches, and with blocking layers, the cell has a capacitance of 18.9 picofarads.



FREEZING APPARATUS SETUP FOR
CYLINDRICAL SAMPLE HOLDER

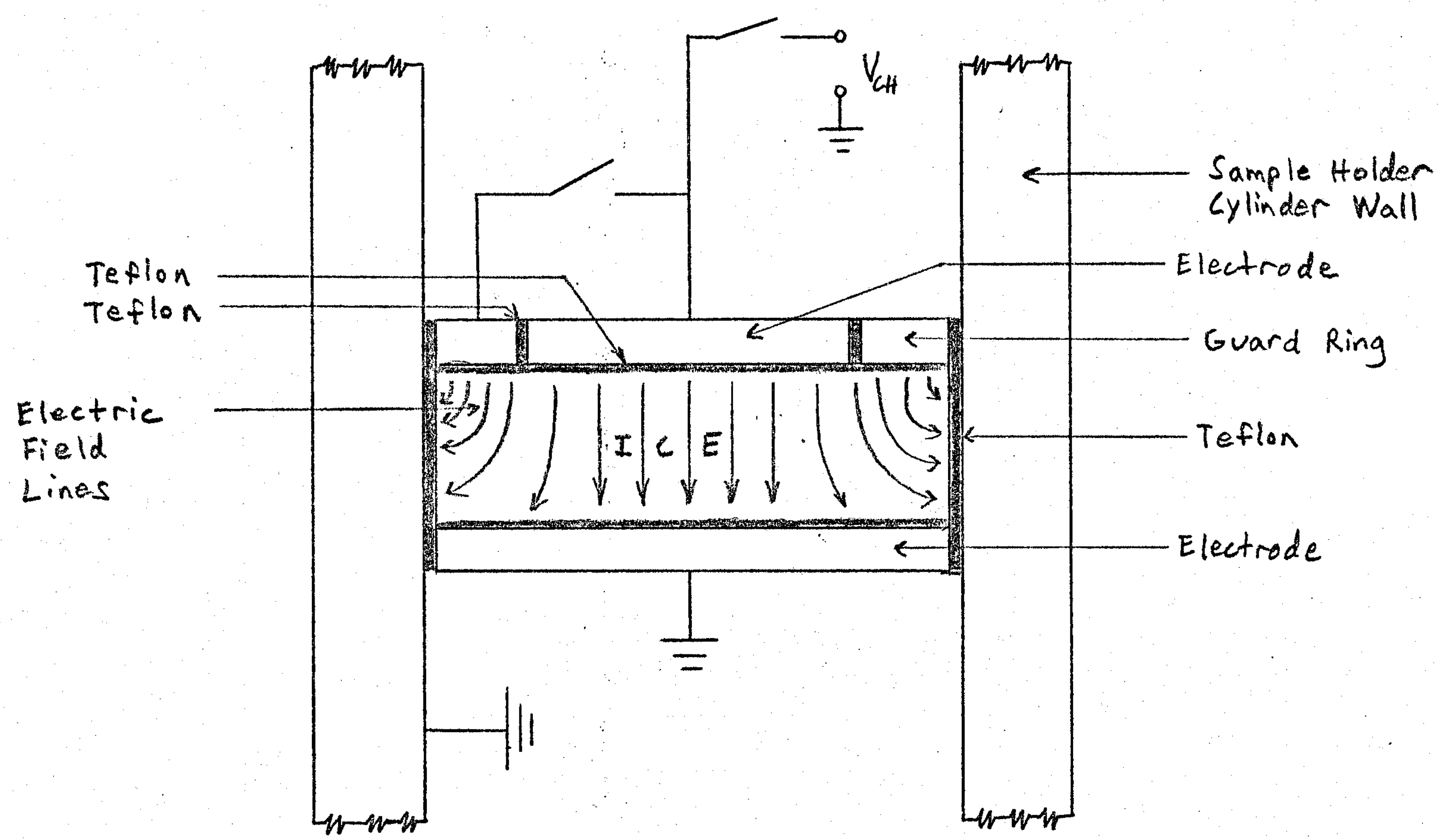
FIG. 3

A copper-constantan thermocouple is inserted into a hole in one of the electrodes to monitor the ice temperature. Temperature differences of 1.2 deg.K, between the top and bottom of the sample, and 1.2 deg.K, between the center and outer edge of the sample, are measured with a heating rate of 0.044 deg.K/sec. This sample holder also has a guarded electrode that can be used instead of the single-piece electrode. The guard electrode, shown in figure 4, has an outer ring insulated from the inner disk by teflon. It is felt that this guarded arrangement will eliminate the fringe effects between the edges of the electrodes and between the high electrode and the grounded wall of the sample holder. The guard ring is connected to the inner disk during charging and is floating during discharging. Upon reviewing of this report it is apparent that an error was made by keeping the guard ring floating instead of grounded. The guard ring should have been grounded to allow image charges, released from the outer edge of the electrode to bypass the ammeter and flow to ground.

Flat ice samples are made from distilled water with a resistivity of approximately 1×10^{6} ohm-cm. The samples are 0.37 inches thick and 1.5 inches in diameter, with surfaces ground parallel and smooth on emery cloth. Of course care is taken not to melt or contaminate the samples during the grinding process. The ice samples are grown and cut using methods described by Gross et. al. (1975), and Gross et. al. (1978).

The procedure used to make the TSD measurements for both sample holders is as follows:

1) Apply an electric field to the sample at 233 deg.K and slowly



GUARD RING ARRANGEMENT FOR FLAT DISK
SAMPLE HOLDER

FIG. 4

cool the sample for 24 hrs. at a cooling rate of 0.1 deg.K/min.

2) Turn off the electric field at 96 deg.K and short the electrodes for 20 minutes

3) Start the heating cycle at a linear rate of 0.019 deg.K/sec with the electrodes connected to the picoammeter.

This procedure is called a full charge test and should charge all polarization mechanisms to their maximum amount. An attempt is made to follow this procedure as closely as possible for every TSD run made, so that different runs can be compared. Also the samples are frozen less than a week before the TSD measurements are made.

Partial charge tests are done by charging the ice sample at a single temperature corresponding to the peak temperature of the peak that is to be isolated. In theory this should fully charge the peak that is wanted and only partially charge any overlapping peak. In practice this is very difficult in ice because the peaks strongly overlap. Previous attempts to isolate peaks by this method, in this laboratory, have failed.

Another method used to isolate TSD peaks is to fully charge the sample and then start the heating process. When the first TSD peak almost reaches its maximum quickly cool the sample so that the overlapping second peak has no chance to discharge. This process can be repeated until the first peak has been almost totally discharged, leaving the second peak pretty well isolated. Again previous attempts, in this laboratory, to accomplish this have failed because of the close proximity of the first two peaks.

In the past these two methods were all that was available to isolate peaks and thus get parameter estimates; however, with the computer model that is used in this study, full charge tests are preferred. One can never be certain that a peak cleaning technique has successfully isolated a peak, but sets of peak parameters can be input to the computer model to find a best fit to the data. This investigator has more confidence in the best fit parameters than in parameters calculated by peak cleaning.

One problem with the two sample holders is that they are two-terminal arrangements. This creates problems in measuring the empty cell capacitance between the two electrodes, which is needed to calculate the dielectric constant of the ice. A three-terminal arrangement would be better because the capacitance between the electrodes wouldn't be affected by the surrounding sample holder, aluminum block and connected cables. However, since the picoammeter has only a two-terminal input, the two-terminal setup will have to suffice.

3-THEORY

One possible polarization mechanism in ice is positive (H_3O^+) and negative (OH^-) ionic defects. Figure 5, which is taken from Jaccard's paper (9), illustrates how by the shifting of protons along O-O bonds, these ions can propagate through the ice and give rise to a net polarization. During charging the H_3O^+ and OH^- ions can migrate toward the cathode and anode respectively. There are probably several ways to hinder the motion of or trap these ionic defects. If the ice temperature is reduced enough then there is insufficient energy for

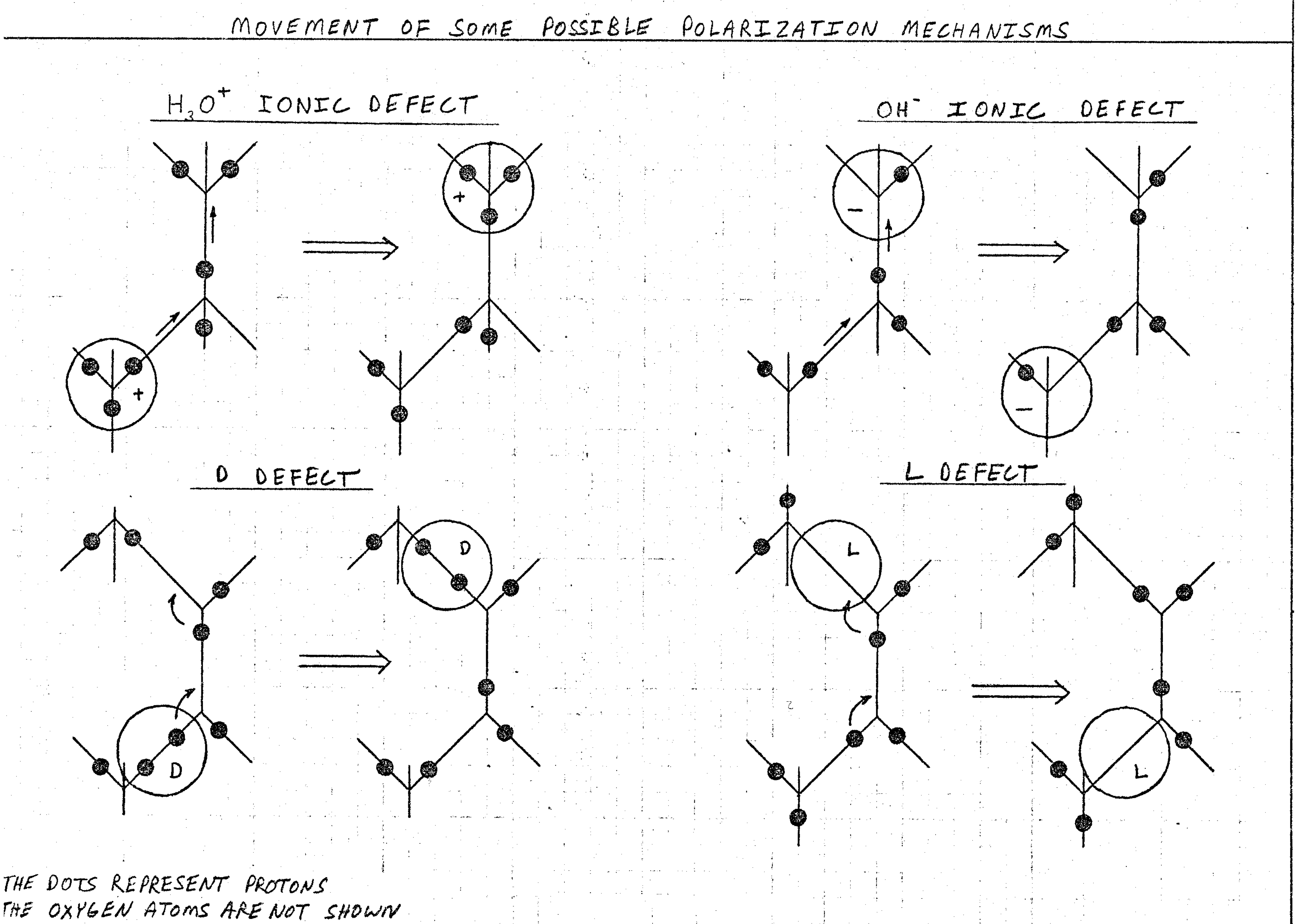

MOVEMENT OF SOME POSSIBLE POLARIZATION MECHANISMS
H3O+ IONIC DEFECT
+
OH- IONIC DEFECT
−
D DEFECT
D
L DEFECT
L
THE DOTS REPRESENT PROTONS
THE OXYGEN ATOMS ARE NOT SHOWN

FIG. 5

protons to shift along O-O bonds. Thus the propagation of ionic defects can be stopped. Dislocations and impurities may also serve as traps of ionic defects.

These ionic defects can undergo some complicated reactions at the ice-electrode surface if no blocking layers are used. The result is a build-up of mobile charges (space charge) at the ice-electrode surfaces, which can then relax by diffusion during TSD.

Another possible polarization mechanism, that is also illustrated in figure 5, is D and L defects. Jaccard defines a D defect as an O-O bond occupied by two protons and an L defect as an O-O bond occupied by no protons. He says that "these defects are produced by the jumping of the protons around the oxygen atoms on an adjacent regular bond, and they can be displaced in the lattice by the continuation of these jumps."[10] The movement of these defects can probably be halted in the same way as ionic defects.

While the polarization mechanisms mentioned above rely on mobile protons, polarization can also result from the slight displacement of atoms in the ice crystal lattice. If this displacement occurs without the influence of an electric field then the ice is ferroelectric. It may also be possible for impurity atoms to migrate through the ice under the influence of an electric field.

Polarization can also result from the injection of homocharges into the ice. van Turnhout describes homocharge as follows. "When the contact between the electrodes and the sample is imperfect, as is usually the case for laid-on electrodes, there are air spaces between them, in which at high field strengths Townsend breakdowns will occur, so that ions or electrons from the air are injected into the sample."[11] Thus homocharge is charge of the same polarity as the nearest charging electrode and would give a current when the homocharges recombine during discharging. The polarization mechanisms mentioned previously are all examples of heterocharge polarization because charges are attracted to the electrode of opposite polarity. In the presentation that follows, homocharge and heterocharge currents will arbitrarily be called negative and positive currents respectively.

3A-COMPUTATIONAL MODEL

The model that is used to fit each TSD current peak, and arrive at the peak parameters, is derived below. van Turnhout (12) starts with a form of the following equation for the polarization during discharging with the minus sign indicating depolarization

$$dP(t)/dt=-(C)P(t) \tag{1}$$

where $P(t)$=polarization

C=constant of proportionality.

This simply says that the change in the polarization is proportional to the polarization. van Turnhout then makes the assumption that equation (1) holds true for varying temperatures so he replaces the constant with a temperature dependent relaxation frequency to get

$$dP(t)/dt+\alpha(T)P(t)=0 \tag{2}$$

where $\alpha(T)$=relaxation frequency of polarization mechanism in sec^{-1}.

For a proton trapped in a potential well of energy depth E, the probability of escape can be represented by the equation[13]

$$\alpha(T)=\alpha_o \, EXP(-E/kT) \tag{3}$$

where k=Boltzman's constant which equals 1.98 cal/deg.K-mole

α_o =pre-exponential factor in sec^{-1}

E=activation energy in cal/mole.

Equation (3) shows that the probability of escape decreases as the potential well depth (E) increases; and as the temperature increases the probability of escape increases due to greater thermal kinetic energy. One assumption that has been made in equation (3) is that each polarization mechanism has a discrete E and α_o instead of a distributed E and α_o.

This is a questionable assumption and should be considered in future work. In an ideal pure ice crystal, L and D defect relaxation would probably require a single E and α_o. However, in a real crystal with impurities and disslocations, a distributed E and or α_o may be more correct because impurity atoms disturb the crystal lattice and reduce the activation energy required to mobilize a D or L defect. Space charge relaxation should almost certainly require a distributed E and or α_o due to the large distance that the charges have to travel to relax.

van Turnhout (14) lists the solution to equation (2) as

$$P(t)=P_o \, EXP(-\int_{t_s}^{t}\alpha(T)\,dt) \tag{4}$$

where P_o =maximum attainable polarization during charging in $coul/cm^2$

t_s =time at end of charging.

In equation (4) I have assumed that maximum polarization was attained during charging because of the slow cooling rate, long charging time, and warm temperature at the start of charging. The integral part of equation (4) accounts for the change in the escape probability as the temperature increases due to heating. The TSD current density is given by differentiating equation (4) with respect to time to get

$$j(t)=-dP/dt=P_o\alpha(T)EXP(-\int_{t_s}^{t}\alpha(T)dt) \quad (5)$$

where j(t)=current density in amperes/cm^2.

The minus sign indicates that depolarization is occurring. Now if a relaxation time

$$\tau(T)=\tau_o EXP(E/kT)=1/\alpha(T) \quad (6)$$

is substituted for the relaxation frequency ($\alpha(T)$), and the variable time is converted to temperature by dividing by the heating rate (assumed to be linear), equation (5) becomes

$$j(T)=(P_o/\tau_o)EXP(-E/kT)EXP((-1/q\tau_o)\int_{T_d}^{T}EXP(-E/kT)dT) \quad (7)$$

where τ_o =pre-exponential factor for relaxation time in sec.

T_d =storage temperature before heating cycle begins

q=heating rate in deg.K/sec.

An assumption that is made in equation (7) is that no polarization is lost between the time charging stops and TSD begins. This is a valid assumption because no discharge current is observed at storage temperatures. van Turnhout (15) substitutes a rational approximation for the current integral

$$\xi(T,T_d) \approx (1/q)\int_{T_d}^{T} EXP(-E/kT)\,dT = (kT^2/qE)\,EXP(-E/kT)\,H(E/kT)$$

where $H(E/kT) = (b1-a1+(b2-a2)(kT/E))(1+b1(kT/E)+b2(kT/E)^2)^{-1}$

a1=2.3347 a2=0.2506 b1=3.3307 b2=1.6815

to get the final form of the model equation

$$j(T) = (P_o/\gamma_o)\,EXP(-E/kT)\,EXP((-kT^2/q\gamma_o E)\,EXP(-E/kT)\,H(E/kT)). \qquad (8)$$

Another assumption is that during the heating cycle there is no net electric field in the sample as figure 6 illustrates. Any polarization field frozen into the ice is balanced by an opposite field created by image charges on the electrodes. It is these image charges that actually flow through the ammeter to register a current.

During charging there are many more charges on the electrode plates than can be compensated for by polarization in the ice. Therefore, the charging field (E) is greater than the polarization field (P), and it is this excess charge, in addition to the polarization which isn't frozen into the ice, that makes up the fast reacting component of the dielectric constant. During discharging the polarization, that is frozen into the ice, is balanced by image charges on the metal electrodes. Thus the dielectric constant is calculated as follows:

$$K = \frac{C_{ice}}{C_{cell}} = \frac{C_{not\ frozen} + C_{frozen}}{C_{cell}} = \frac{C_{not\ frozen}}{C_{cell}} + \frac{A\int j(T)\,dT}{V\,C_{cell}} = \varepsilon_\infty + \frac{P_o A}{V\,C_{cell}} \qquad (9)$$

where K = dielectric constant

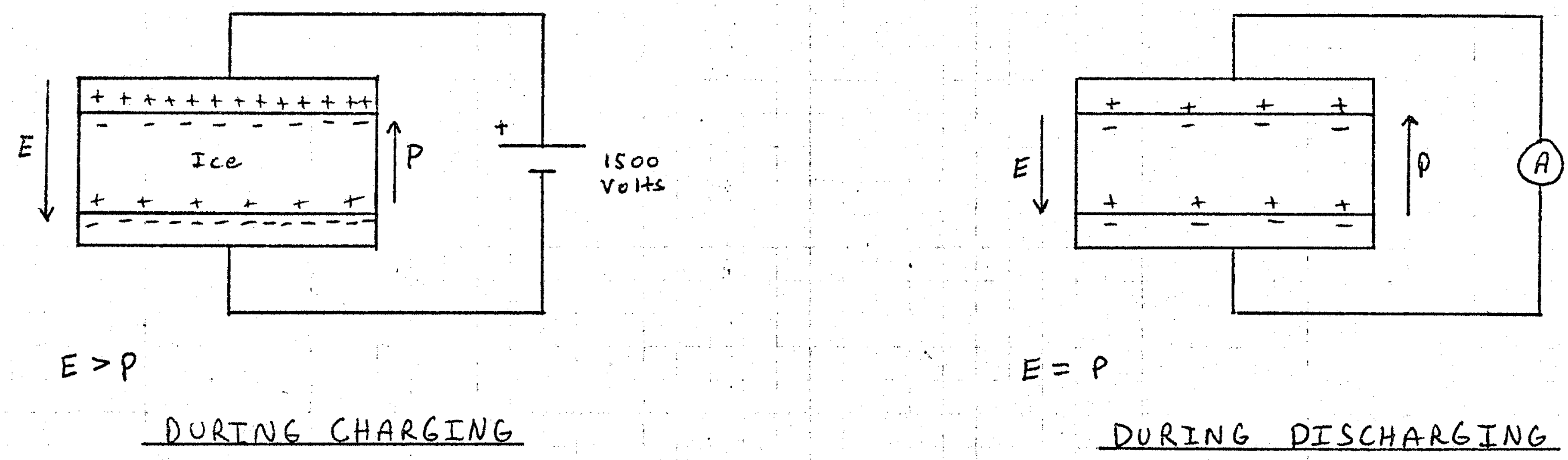

E
Ice
P
+
1500 Volts
E > P
DURING CHARGING
E
P
A
E = P
DURING DISCHARGING

FIG. 6

ε_{∞} = component of dielectric constant that relaxes instantaneously when the electric field is interrupted

ε_s = component of dielectric constant that is frozen into the ice

V = charging voltage in volts.

So ε_s can be calculated once the area under a peak (P_o) and the capacitance of the empty sample holder (C_{cell})[16] are known. ε_{∞} is approximately equal to 3.1. If the peak parameter P_o is used then the above equation calculates the dielectric constant for just that peak. However, if the dielectric constant for the complete polarization spectrum is needed, then the area under the whole discharge curve is substituted for P_o.

Estimates of E and γ_o must also be obtained[17] to use equation (8). For the low temperature tail of the current plot (for $j(T) \leq 1/2 j(T)_{max}$):

$$j(T) \approx (P_o/\gamma_o)(C1)EXP(-E/kT) \approx (C2)EXP(-E/kT)$$

where C1 and C2 are constants.

Now taking the natural log of both sides of the equation gives

$$\ln(j) \approx C3 - E/kt$$

where C3 is a constant.

Thus a straight line results when lnj is plotted as a function of 1/kT, the slope of which is E. Taking the derivative of equation (8) with respect to T will give the current peak. Setting this derivative equal to zero will give the following relation for the peak temperature:

$$E/kT_p = (T_p/q\gamma_o)EXP(-E/kT_p)$$

where T_p = the peak temperature.

Solving this equation for γ_o gives an estimate of γ_o equal to:

$$\gamma_o = (T_p^2 k/qE)EXP(-E/kT_p).$$

Once initial parameter guesses are calculated for each current peak, these guesses are plugged into a least-squares inversion program to model the TSD data. The modeling program, an example of a parameter file and a test run are all listed in appendix VII. Appendix VI contains a brief mathematical description of how the computer modeling technique works. The program is capable of handling a TSD spectrum of up to 5 peaks.

There are several things to keep in mind when using the modeling program. The initial parameter guesses must be reasonably close to the actual parameters for the model to work. This means that E and γ_o should combine to give a peak close to the real peak. P_o is not important because the model can easily change that to fit the data. The modeling program is very poor at changing γ_o to fit the slope of the data curve. Thus γ_o must be changed, after looking at the program output, and the program run again. Usually, for every order of magnitude that γ_o is increased by, E should be decreased by $.05 \times 10^4$. The program also refuses to locate a peak under a valley in the TSD curve, so it is difficult to fill in any intervals between TSD peaks.

The modeling program seems to fit the TSD data pretty well if the initial parameter uncertainties are of the same order of magnitude as the initial parameters. The final parameter uncertainties that the program gives are meaningless because of the difficulties of determining γ_o. Generally γ_o can be changed by an order of magnitude or more and with a slight compensation in E the fit will look just as good. Therefore, the computer model gives rough estimates of peak parameters that fit the TSD data. Most likely each TSD peak has more than one relaxation mechanism responsible for it anyway; so the results that the computer model gives are probably sufficient. Indeed it saves a lot of time that would be spent trying to arrive at peak parameters by hand because the peaks overlap so strongly.

A few improvements have been made over the previous TSD modeling program that was used in this research. The derivatives that are used to form the A matrix are now exact derivatives instead of approximations. The modeling program has also been simplified. Before a systems library matrix inversion subroutine, and eigenvalue-eigenvector analysis were both used to invert the TSD data and arrive at the parameters. While the eigenvalue-eigenvector analysis helped to understand how the inversion method works, it slowed the program down and didn't improve the results. So this has been eliminated from the program. In general the new program is a quick and dirty version of the old one.

Now the assumption, that during discharging there is no internal electric field deserves a few comments. Since there is no net electric field to attract positive charges to negative charges, relaxation will be controlled by the diffusion rates of different ions and defects. Free charges, that can migrate through the bulk of the ice, are sometimes called space charge. The diffusion rate of space charge is probably influenced by the mass and size, of free charge carriers, as well as by dislocations in the ice, which increase the mean path length the ion must travel.

van Turnhout (18) gives the following disscussion on the importance of the heating rate. "The important experimental parameter is the heating rate, q; this affects the height and position of the TSD peaks. The current peak increases and broadens with heating rate. This is so because, if q is higher, the same charge has to be released in a shorter time. It is only the initial slope proportional to $\alpha(T)$ that remains the same. The current maximum varies almost proportionally to the heating rate. At the same time, it shifts to a higher temperature, because the ice responds less quickly to a higher heating rate." In addition van Turnhout lists the following equation that relates heating rates to peak temperatures

$$(T1^2/q1)\alpha(T1)=(T2^2/q2)\alpha(T2) \tag{10}$$

where q1 and q2 are heating rates in deg.K/sec

T1 and T2 are peak temperatures in deg.K.

Equation (10) becomes

$$(T1^2/(q1\gamma_o))EXP(-E/kT1)=(T2^2/(q2\gamma_o))EXP(-E/kT2) \tag{11}$$

which can then be solved for E to get

$$E=k*LN((T2^2/q2)/(T1^2/q1))/(1/T2-1/T1). \tag{12}$$

Equation (12) provides a way of calculating E from the results of heating rate tests.

4-RESULTS

The results listed in tables 1 thru 6 are based on data taken from 18 samples frozen in the concentric-cylinder sample holder. All 18 samples were frozen from distilled water and, unless otherwise indicated, were charged with a charging voltage of 1500 volts and heated with a heating rate of .019 deg.K/sec. TSD runs were made both with and without teflon blocking layers.

A few comments about the freezing conditions are needed here. Ice was frozen under atmospheric conditions, an 11 PSI vacuum and under pressurized carbon dioxide. However the exact pressure of the carbon dioxide over the freezing water is unknown after the bell jar valve is closed. Thus better control over the gas conditions is needed. Also the ice samples are most likely polycrystalline because the freezing arrangement gave little control over the freezing rate.

In tables 1 thru 6 the total charge released from the electrodes is calculated by integrating the area under the TSD plot. An integrating program was written to accomplish this and is listed in appendix VIII. The program outputs to a plot file the total charge released versus temperature. The data input to the integrating program are the same data files that are used by the modeling program. Current values, thermocouple EMF'S and the time interval between data points are required. When the digital printer is used the time interval is a set constant. For concentric-cylinder samples the time interval, between data points, is usually 60 sec. for cold points and 120 sec. for the warmer points where less resolution is required.

The dielectric constants are calculated by substituting the total charge released, or the parameter P_o, into equation (9) listed in the theory. The average results that are shown in table 6 are all arithmetic mean values except for γ_o which is a geometric mean value.

Table 1, and appendix III, list data collected for samples frozen under an 11 PSI vacuum in the concentric-cylinder sample holder. Ice samples were frozen both with and without teflon blocking layers. The data shows that ice exhibits three major TSD peaks with peak temperatures and heights (P_o) that vary from sample to sample. The third peak presents a problem, because its peak temperature is so inconsistent that it is difficult to tell if a sporadic peak is the third peak or not. The two coldest peaks are much more consistent in both peak temperature and height. Peaks that are too ill-defined to give reliable data are represented by a dash in the data tables.

Superposed over most of the TSD spectrum is a more or less continuous discharge current that is most apparent between the second and third peaks. When teflon blocking layers are used, this discharge current can actually be opposite in magnitude to the three main peaks, as is illustrated in figure 7. This current causes problems in modeling TSD peaks because the model requires that the tails of the peaks go to zero. When no teflon blocking layers are used this discharge current can substantially add to the dielectric constant calculated from just

TABLE 1

Results For Ice Samples Frozen Under An .11 Psi Vacuum With A Heating Rate Of .019 °K/sec And A Charging Voltage Of 1500 Volts

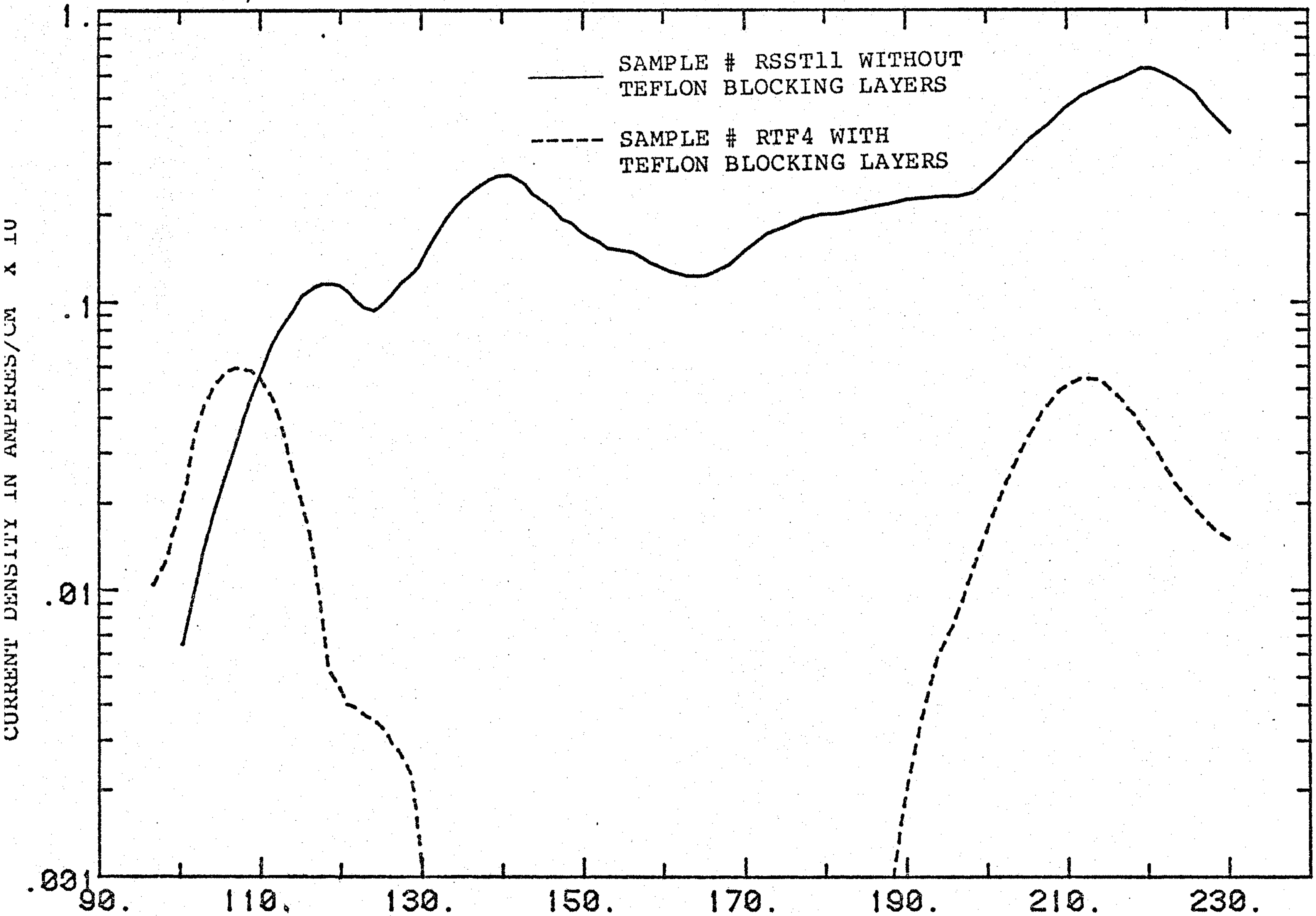
Sample # And Run #	Peak #	Peak Temp. (°K)	Peak Parameters E (cal/mole)	τ_0 (sec)	P_0 (coul/cm²)	Total Charge Released From 90°K To 230°K (coul/cm²)	Dielectric Constant From 90°K To 230°K	Comments
RSST1 F142	1	115.8	$.551\times10^{4}$	$.817\times10^{-8}$	$.107\times10^{-7}$	19.0×10^{-8}	727.0	No Blocking Layers Used
	2	133.6	$.582\times10^{4}$	$.818\times10^{-7}$	$.835\times10^{-8}$			
	3	223.8	—	—	—			
RSST2 F151								No Blocking Layers Used Different Heating Rate And Charging Voltage
RSST3 F162	1	112.9	$.600\times10^{4}$	$.611\times10^{-9}$	$.149\times10^{-7}$	4.0×10^{-8}	155.5	No Blocking Layers Used
	2	—	—	—	—			
	3	—	—	—	—			
RSST4 F164								No Blocking Layers Used Sample Was Contaminated Resistivity = 2.8×10^{4} Ω-cm
RSST5 F165								No Blocking Layers Used Probably Contaminated
RSST6 F170	1	115.8	$.407\times10^{4}$	$.745\times10^{-5}$	$.495\times10^{-8}$	3.8×10^{-8}	147.9	No Blocking Layers Used Sample Resistivity Was 1×10^{6} Ω-cm
	2	141.5	$.697\times10^{4}$	$.528\times10^{-8}$	$.723\times10^{-8}$			
	3	223.2	—	—	—			
RSST7 F178	1	113.0	$.591\times10^{4}$	$.937\times10^{-9}$	$.100\times10^{-7}$	6.0×10^{-8}	231.7	No Blocking Layers Used Sample Resistivity Was 5.7×10^{5} Ω-cm
	2	137.3	$.571\times10^{4}$	$.272\times10^{-6}$	$.766\times10^{-8}$			
	3	232.5	—	—	—			
RSST8 F182	1	120.4	$.557\times10^{4}$	$.126\times10^{-7}$	$.886\times10^{-8}$	10.0×10^{-8}	384.1	No Blocking Layers Used Sample Resistivity After 3rd Refreeze Was 6.4×10^{5} Ω-cm
	2	133.6	$.494\times10^{4}$	$.267\times10^{-5}$	$.169\times10^{-7}$			
	3	223.8	—	—	—			
RSST9 F186	1	112.0	$.537\times10^{4}$	$.867\times10^{-8}$	$.402\times10^{-8}$	12.0×10^{-8}	460.3	No Blocking Layers Used
	2	137.8	$.378\times10^{4}$	$.521\times10^{-3}$	$.171\times10^{-7}$			
	3	219.9	—	—	—			

TABLE 1 CONTINUED

Results For Ice Samples Frozen Under An .11 PSI Vacuum With A Heating Rate Of .019°K/sec And A Charging Voltage Of 1500 Volts

RSST10 F192	1	116.3	$.491 \times 10^{4}$	$.121 \times 10^{-6}$	$.118 \times 10^{-7}$	13.0×10^{-8}	498.4	No Blocking Layers Used This Is 1st Refreeze Because Original Wasn't Frozen Under A Vacuum
	2	129.3	$.474 \times 10^{4}$	$.351 \times 10^{-5}$	$.190 \times 10^{-7}$			
	3	226.7	—	—	—			
RSST11 F198	1	117.9	$.520 \times 10^{4}$	$.652 \times 10^{-7}$	$.765 \times 10^{-8}$	17.0×10^{-8}	650.8	No Blocking Layers Used
	2	141.0	$.538 \times 10^{4}$	$.200 \times 10^{-5}$	$.287 \times 10^{-7}$			
	3	220.2	—	—	—			
RSST12								No Blocking Layers Used No Run Of Original Sample
RTF1 F152	1	113.9	$.679 \times 10^{4}$	$.177 \times 10^{-10}$	$.608 \times 10^{-8}$	2.5×10^{-8}	88.5	Teflon Blocking Layers Used
	2	—	—	—	—			
	3	—	—	—	—			
RTF2 F154	1	112.0	$.549 \times 10^{4}$	$.497 \times 10^{-8}$	$.548 \times 10^{-8}$	2.2×10^{-8}	78.2	Teflon Blocking Layers Used
	2	136.5	—	—	—			
	3	—	—	—	—			
RTF3 F158	1	113.0	$.683 \times 10^{4}$	$.132 \times 10^{-10}$	$.708 \times 10^{-8}$	1.6×10^{-8}	57.7	Teflon Blocking Layers Used
	2	—	—	—	—			
	3	231.9	—	—	—			
RTF4 F208	1	107.7	$.571 \times 10^{4}$	$.475 \times 10^{-9}$	$.306 \times 10^{-8}$	1.0×10^{-8}	37.2	Teflon Blocking Layers Used
	2	—	—	—	—			
	3	212.6	—	—	—			
RTF5 F212	1	109.2	$.441 \times 10^{4}$	$.470 \times 10^{-6}$	$.476 \times 10^{-8}$	2.1×10^{-8}	74.8	Teflon Blocking Layers Used
	2	129.7	$.647 \times 10^{4}$	$.303 \times 10^{-8}$	$.271 \times 10^{-8}$			
	3	231.6	—	—	—			
RTF6 F216	1	116.3	$.714 \times 10^{4}$	$.494 \times 10^{-11}$	$.536 \times 10^{-8}$	2.5×10^{-8}	88.5	Teflon Blocking Layers Used
	2	—	—	—	—			
	3	229.6	—	—	—			

SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOL TAGE IS 1500 VOLTS.



the two coldest peaks, as can be seen by comparing ε_s for the two peaks with ε_s calculated from 90 deg.K to 230 deg.K, in table 6.

Table 2 lists data collected for samples refrozen under an 11 PSI vacuum in the concentric-cylinder sample holder. TSD plots for refrozen samples are illustrated in appendix III. Averaged differences between refrozen and original samples are given in table 6.

Table 3 lists data collected for samples refrozen under a carbon dioxide atmosphere in the concentric-cylinder sample holder. TSD plots for these samples are again shown is appendix III, and averaged differences between original samples, samples refrozen under an 11 PSI vacuum, and samples refrozen under CO_2 are given in table 6.

One problem that was encountered with freezing under carbon dioxide was that the sample volume greatly increased due to the frozen in gas. In some cases a portion of the sample was lost over the sides of the sample holder due to expansion. This can be compensated for by removing some of the water before freezing but it is difficult to know how much to remove. This lends some uncertainty to plots that compare TSD runs of samples before and after refreezing under carbon dioxide.

Presented in table 4 are the data for the heating rate tests that were done on sample # RSST1. TSD plots of these runs are shown in appendix IV. Reducing the heating rate from .034 to .009 deg.K/sec reduces the first peak temperature by an average of 3.1 deg.K. The second and third peaks were not well defined so no conclusions can be made about them. Varying the heating rate has no effect on the total charge released from the electrodes, as is illustrated by the constant

TABLE 2

Results For Ice Samples That Were Repeatedly Refrozen Under An 11 PSI Vacuum With A Heating Rate Of .019 °K/sec And A Charging Voltage Of 1500 Volts

Sample # And Run #	Peak #	Peak Temp. (°K)	Peak Parameters E (cal/mole)	τ_0 (sec)	P_0 (coul/cm²)	Total Charge Released From 90°K To 230°K (coul/cm²)	Dielectric Constant From 90°K To 230°K	Comments
RSST8 F185	1	116.3	$.559\times10^{4}$	$.646\times10^{-8}$	$.142\times10^{-7}$	10×10^{-8}	384.1	No Blocking Layers Used This Is The 3rd Refreeze Sample Resistivity $=6.4\times10^{5}$ Ω-cm
	2	—	—	—	—			
	3	209.6	—	—	—			
RSST9 F189	1	109.1	$.531\times10^{4}$	$.688\times10^{-8}$	$.111\times10^{-7}$	7.9×10^{-8}	304.1	No Blocking Layers Used This Is The 3rd Refreeze
	2	132.3	$.497\times10^{4}$	$.235\times10^{-5}$	$.706\times10^{-8}$			
	3	215.7	—	—	—			
RSST10 F196	1	112.0	$.484\times10^{4}$	$.118\times10^{-6}$	$.152\times10^{-7}$	9.5×10^{-8}	365.1	No Blocking Layers Used This Is The 3rd Refreeze
	2	134.4	—	—	—			
	3	227.3	—	—	—			
RSST11 F201	1	113.9	$.461\times10^{4}$	$.342\times10^{-6}$	$.129\times10^{-7}$	9.2×10^{-8}	353.6	No Blocking Layers Used This Is The 3rd Refreeze
	2	134.8	$.408\times10^{4}$	$.925\times10^{-4}$	$.167\times10^{-7}$			
	3	226.7	—	—	—			
RSST12 F205	1	120.4	$.507\times10^{4}$	$.123\times10^{-6}$	$.127\times10^{-7}$	13.0×10^{-8}	498.4	No Blocking Layers Used This Is The 4th Refreeze
	2	134.0	$.495\times10^{4}$	$.352\times10^{-5}$	$.207\times10^{-7}$			
	3	—	—	—	—			
RTF4 F210	1	111.4	$.586\times10^{4}$	$.484\times10^{-9}$	$.497\times10^{-8}$	1.3×10^{-8}	47.5	Teflon Blocking Layers Used This Is The 2nd Refreeze
	2	—	—	—	—			
	3	—	—	—	—			
RTF5 F214	1	108.0	$.484\times10^{4}$	$.495\times10^{-7}$	$.666\times10^{-8}$	1.9×10^{-8}	67.9	Teflon Blocking Layers Used This Is The 3rd Refreeze
	2	—	—	—	—			
	3	225.8	—	—	—			
RTF6 F218	1	110.1	$.734\times10^{4}$	$.534\times10^{-12}$	$.709\times10^{-8}$	1.9×10^{-8}	67.9	Teflon Blocking Layers Used This Is The 3rd Refreeze
	2	—	—	—	—			
	3	234.5	—	—	—			

TABLE 3

Results For Ice Samples That Were Refrozen Under A Carbon Dioxide Atmosphere With A Heating Rate Of .019 °K/sec And A Charging Voltage Of 1500 Volts

mple # Run #	Peak #	Peak Temp. (°K)	Peak Parameters E (cal/mole)	τ_0 (sec)	P_0 (coul/cm²)	Total Charge Released From 90°K To 230°K (coul/cm²)	Dielectric Constant From 90°K To 230°K	Comments
ST9 190	1	114.9	$.547\times10^{4}$	$.825\times10^{-8}$	$.973\times10^{-8}$	43.0×10^{-8}	1641.5	No Blocking Layers Use pH = 4.72
	2	—	—	—	—			
	3	220.8	—	—	—			
ST11 203	1	123.1	$.464\times10^{4}$	$.180\times10^{-5}$	$.704\times10^{-8}$	52.0×10^{-8}	1984.4	No Blocking Layers Use
	2	144.3	$.545\times10^{4}$	$.230\times10^{-5}$	$.931\times10^{-8}$			
	3	227.6	—	—	—			
ST12 207	1	116.3	$.436\times10^{4}$	$.185\times10^{-5}$	$.479\times10^{-8}$	48×10^{-8}	1832.0	No Blocking Layers U
	2	141.0	—	—	—			
	3	220.5	—	—	—			
TF4 211	1	108.2	$.439\times10^{4}$	$.498\times10^{-6}$	$.545\times10^{-8}$	3.3×10^{-8}	115.8	Teflon Blocking Laye Used
	2	—	—	—	—			
	3	224.1	—	—	—			
TF5 215	1	111.7	$.551\times10^{4}$	$.498\times10^{-8}$	$.502\times10^{-8}$	3.0×10^{-8}	105.5	Teflon Blocking Lay Used
	2	—	—	—	—			
	3	—	—	—	—			
TF6	1	112.0	$.734\times10^{4}$	$.729\times10^{-12}$	$.512\times10^{-8}$	2.4×10^{-8}	85.0	Teflon Blocking Lay Used
	2	—	—	—	—			
	3	212.7	—	—	—			

TABLE 4

The Results Of Heating Rate Tests Done On Ice Samples Without Teflon Blocking Layers

...le # ...un #	Heating Rate (°K/sec)	Charging Voltage (Volts)	Peak #	Peak Temp. (°K)	Total Charge Released From 90°K To 230°K (coul/cm²)	Dielectric Constant From 90°K To 230°K
...TI ...5	.034	500	1 2 3	116.7 — 234.8	4.1×10^{-8}	471.8
TI 7	.019	500	1 2 3	116.3 — 238.2	4.1×10^{-8}	471.8
TI 48	.009	500	1 2 3	115.3 — —	4.1×10^{-8}	471.8
TI 43	.034	1500	1 2 3	116.3 — —	15.0×10^{-8}	574.6
TI 42	.019	1500	1 2 3	115.8 133.6 223.8	19.0×10^{-8}	727.0
...TI 44	.009	1500	1 2 3	111.5 133.0 220.8	15.0×10^{-8}	574.6

value of the dielectric constant.

The charging voltage has a predictable effect on peak heights as can be seen from the results listed in table 5, and from the corresponding TSD runs given in appendix II. If the charging voltage is tripled, from 500 to 1500 volts, the average charge released, up to 230 deg.K, increases by a factor of 3.2. This is almost a linear response. More specifically, the first two peak heights increase by average factors of 2.4 and 3.6 respectively, although these figures are rough estimates due to peak overlapping. These averages are based on charging voltage tests run on three different samples.

Table 6 contains a summary of the refreezing tests that were done on samples both with and without teflon blocking layers. One noticeable trend is that when samples are refrozen, under an 11 PSI vacuum, the first peak temperature decreases, by 1.6 deg.K for samples without blocking layers, and by 2.2 deg.K for samples with blocking layers. The second peak temperature decreases, by 2.4 deg.K for samples without blocking layers, and by an unknown amount for samples with blocking layers. In fact, refreezing with blocking layers makes the second peak almost disappear. The third peak temperature decreases by 4.5 deg.K without blocking layers, and increases by 3.7 deg.K with blocking layers.

Refreezing of ice samples under carbon dioxide had the following effect on peak temperatures. The first peak temperature remained the same for samples without blocking layers, and decreased by 1.4 deg.K for samples with blocking layers. The second peak temperature increased, by 6.4 deg.K for samples without blocking layers, and by

TABLE 5

The Results of Charging Voltage Tests Done On Ice Samples Without Teflon Blocking Layers

Sample # And Run #	Heating Rate (°K/sec)	Charging Voltage (volts)	Peak #	Peak Temp. (°K)	Total Charge Released From 90°K To 230°K (coul/cm²)	Dielectric Constant From 90°K To 230°K
RSST1 F143	.033	1500	1 2 3	116.3 — —	15.0×10^{-8}	574.6
RSST1 F145	.033	500	1 2 3	116.7 — 234.8	4.1×10^{-8}	471.7
RSST1 F146	.033	230	1 2 3	117.4 — 236.8	1.9×10^{-8}	475.2
RSST7 F178	.019	1500	1 2 3	112.5 137.5 232.8	6.0×10^{-8}	231.7
RSST7 F179	.019	1000	1 2 3	112.0 137.3 233.1	3.8×10^{-8}	220.3
RSST7 F180	.019	500	1 2 3	112.0 136.1 230.5	2.2×10^{-8}	254.6
RSST10 F192	.019	1500	1 2 3	116.3 129.3 226.7	13.0×10^{-8}	498.4
RSST10 F194	.019	1000	1 2 3	116.3 128.9 223.8	7.5×10^{-8}	431.7
RSST10 F193	.019	500	1 2 3	116.7 128.9 226.7	4.0×10^{-8}	460.3

TABLE 6

Averaged Results Compiled From Tables 1, 2 & 3. A Heating Rate Of .019 °K/sec And A Charging Voltage Of 1500 Volts Was Used:

Peak #	Peak Temp. (°K)	Peak Parameters E (cal/mole)	τ_0 (sec)	P_0 (coul/cm²)	Total Charge Released From 90°K To 230°K (coul/cm²)	Dielectric Constant From 90°K To 230°K	Dielectric Constant For Each Peak	Comments
1 2 3	115.5 136.3 224.3	$.532\times10^{4}$ $.533\times10^{4}$ —	$.204\times10^{-7}$ $.102\times10^{-5}$ —	$.911\times10^{-8}$ $.151\times10^{-7}$ —	10.6×10^{-8}	407.0	37.8 60.6 —	Ice Samples Frozen Under An 11 PSI Vacuum With No Teflon Blocking Layers
1 2 3	113.9 133.9 219.8	$.508\times10^{4}$ $.467\times10^{4}$ —	$.466\times10^{-7}$ $.931\times10^{-5}$ —	$.132\times10^{-7}$ $.148\times10^{-7}$ —	9.9×10^{-8}	380.3	53.4 59.5 —	Ice Samples Repeatedly Refrozen Under An 11 PSI Vacuum With No Teflon Blocking Layers
1 2 3	115.6 142.7 223.3	$.482\times10^{4}$ $.545\times10^{4}$ —	$.302\times10^{-6}$ $.230\times10^{-5}$ —	$.719\times10^{-8}$ $.931\times10^{-8}$ —	47.7×10^{-8}	1820.6	30.5 38.6 —	Ice Samples Refrozen Under Carbon Dioxide With No Teflon Blocking Layers
1 2 3	112.0 133.1 226.4	$.606\times10^{4}$ $.647\times10^{4}$ —	$.792\times10^{-7}$ $.303\times10^{-8}$ —	$.530\times10^{-8}$ $.271\times10^{-8}$ —	2.0×10^{-8}	71.4	21.2 12.4 —	Ice Samples Frozen Under An 11 PSI Vacuum With Teflon Blocking Layers
1 2 3	109.8 — 230.1	$.601\times10^{4}$ — —	$.234\times10^{-9}$ — —	$.624\times10^{-8}$ — —	1.7×10^{-8}	61.1	24.4 — —	Ice Sample Repeatedly Refrozen Under An 11 PSI Vacuum With Teflon Blocking Layers
1 2 3	110.6 — 218.4	$.575\times10^{4}$ — —	$.122\times10^{-8}$ — —	$.520\times10^{-8}$ — —	2.9×10^{-8}	102.1	20.9 — —	Ice Samples Refrozen Under Carbon Dioxide With Teflon Blocking Layers

an unknown amount for samples with blocking layers. The third peak temperature decreased, by 1 deg.K for samples without blocking layers, and by 8 deg.K for samples with blocking layers.

Table 6 also shows that refreezing of ice samples, under an 11 PSI vacuum, changes the peak heights as can be seen by comparing the P_o values. Samples with and without teflon blocking layers show the same trend of the first peak height increasing and the second peak height decreasing. The third peak height shows an inconsistent response. Refreezing of ice samples under carbon dioxide decreased the first two peak heights and increased the third.

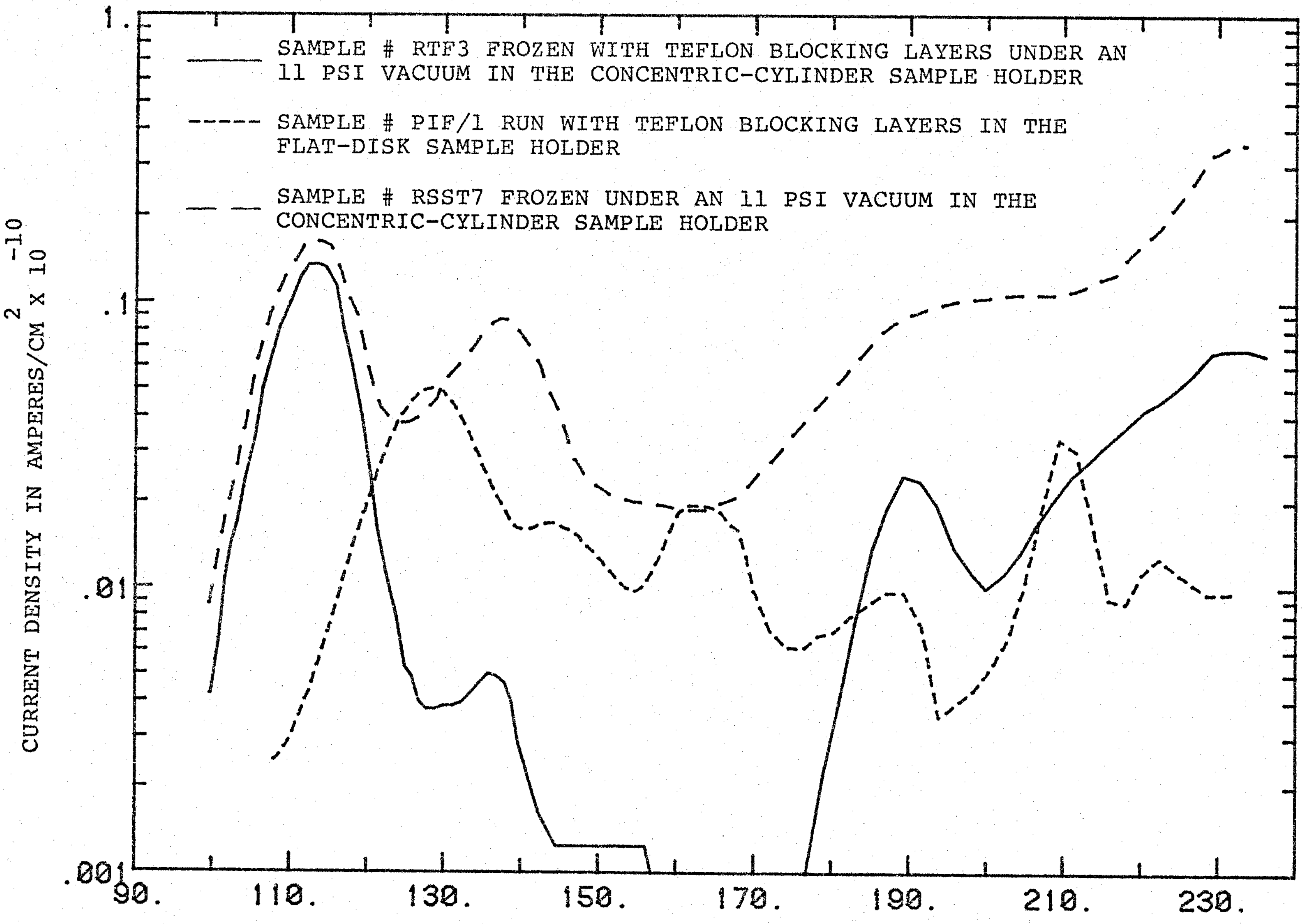
Refreezing of ice under carbon dioxide has a radical effect on the dielectric constant calculated from 90 to 230 deg.K. When comparing samples frozen under an 11 PSI vacuum to samples frozen under carbon dioxide, the dielectric constant increases by 4.5 times without blocking layers and by only 1.4 times with blocking layers. This is a pretty big disparity. It should be noted that the increase in the two dielectric constants is due to increases in the continuous discharge current between the second and third peaks, and the third peak itself.

Reliable estimates of the first two peak's parameters are difficult to come by because of strong overlapping of the peaks. The best estimate of the first peak's parameters is probably given by the ice samples that were repeatedly refrozen, under an 11 PSI vacuum, with blocking layers. These TSD runs seemed to give the sharpest and most isolated first peak. Thus the parameters are $E = .601 \times 10^{4}$ cal/mole, $\tau_o = .234 \times 10^{-9}$ sec and $P_o = .624 \times 10^{-8}$ coul/cm^2. The best estimate of the second peak's parameters is probably given by the original samples which were frozen under an 11 PSI vacuum. These TSD runs gave the largest second peak and smallest first peak. The parameters are $E = .532 \times 10^{4}$ cal/mole, $\tau_o = .204 \times 10^{-7}$ sec and $P_o = .911 \times 10^{-8}$ coul/cm^2. These second peak parameter estimates are not as reliable as the first peak parameter estimates.

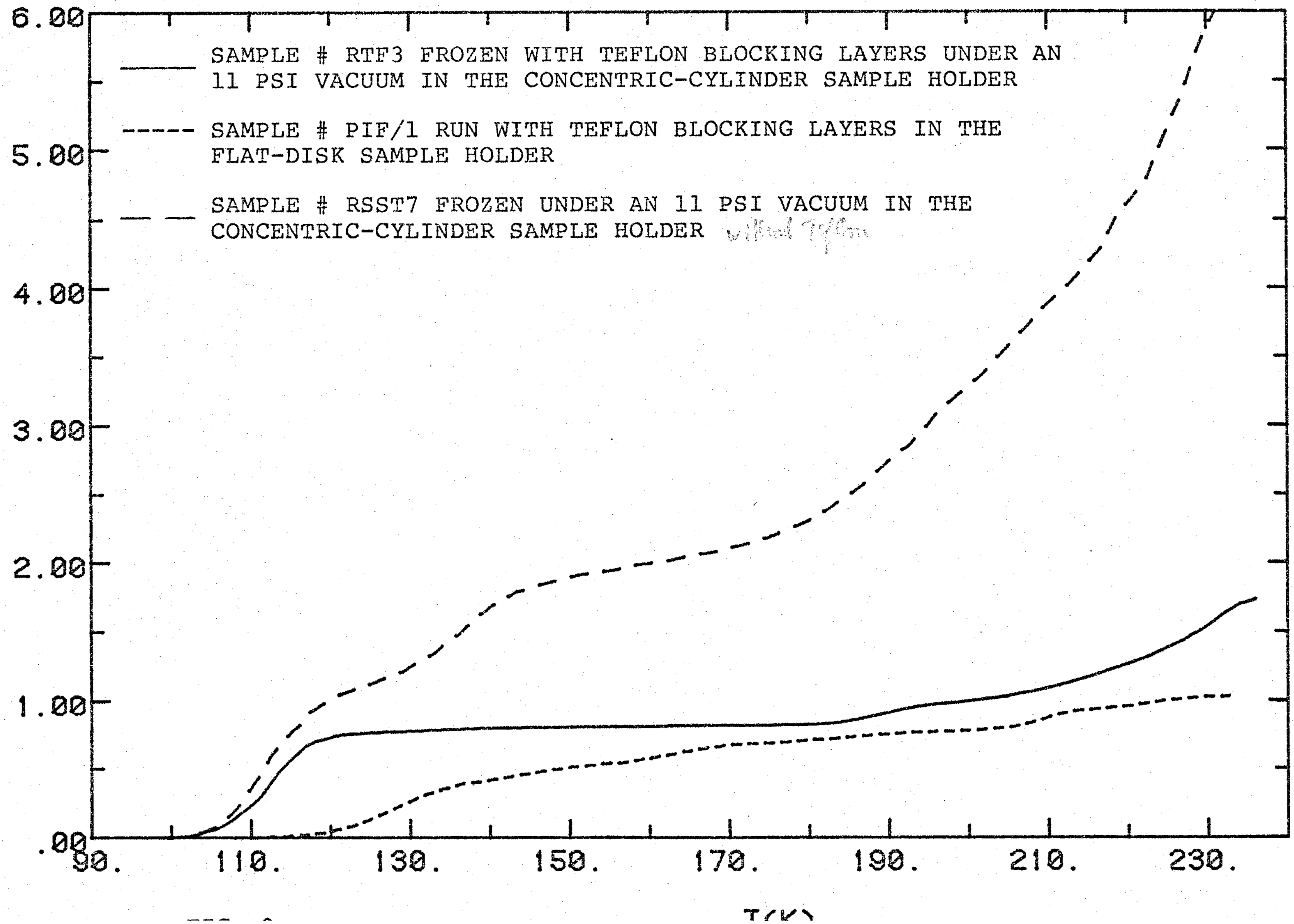
Data for ice samples run in the flat-disk sample holder is not included in these results for two reasons. The heat flow in the flat-disk sample holder is not as good as in the concentric-cylinder sample holder. This and the fact that the thermocouple is not frozen into the ice leads to peaks that are about 16 deg.K warmer than peaks obtained using the concentric-cylinder sample holder. This temperature shift can be seen in figure 8. Also it is uncertain what surface area to divide the current by to get a current density. When the guard ring is connected to the inner disk, the surface area should be 11.34 cm^2, and when the guard ring is floating the area should be 3.80 cm^2. However, if these numbers are used, runs done on the same sample with the guard ring floating and connected don't give identical results. Again this discrepancy may be due to the error of not having the guard ring grounded. This can be seen in appendix X. Except for the temperature shift, the flat-disk samples, with teflon blocking layers, store about the same amount of charge per unit surface as the concentric-cylinder samples with teflon blocking layers. This can be seen in figure 9. The flat-disk samples were ground to the same thickness as the concentric-cylinder samples so that the cumulative charge densities could be compared.

Figures 10 and 11 are examples of actual TSD data that haven't

A COMPARISON OF TSD RUNS OF DIFFERENT SAMPLES FROZEN IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER AND FLAT-DISK SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WERE USED.



A COMPARISON OF THE CUMULATIVE CHARGE RELEASED OF DIFFERENT SAMPLES FROZEN IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER AND FLAT-DISK SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WERE USED.



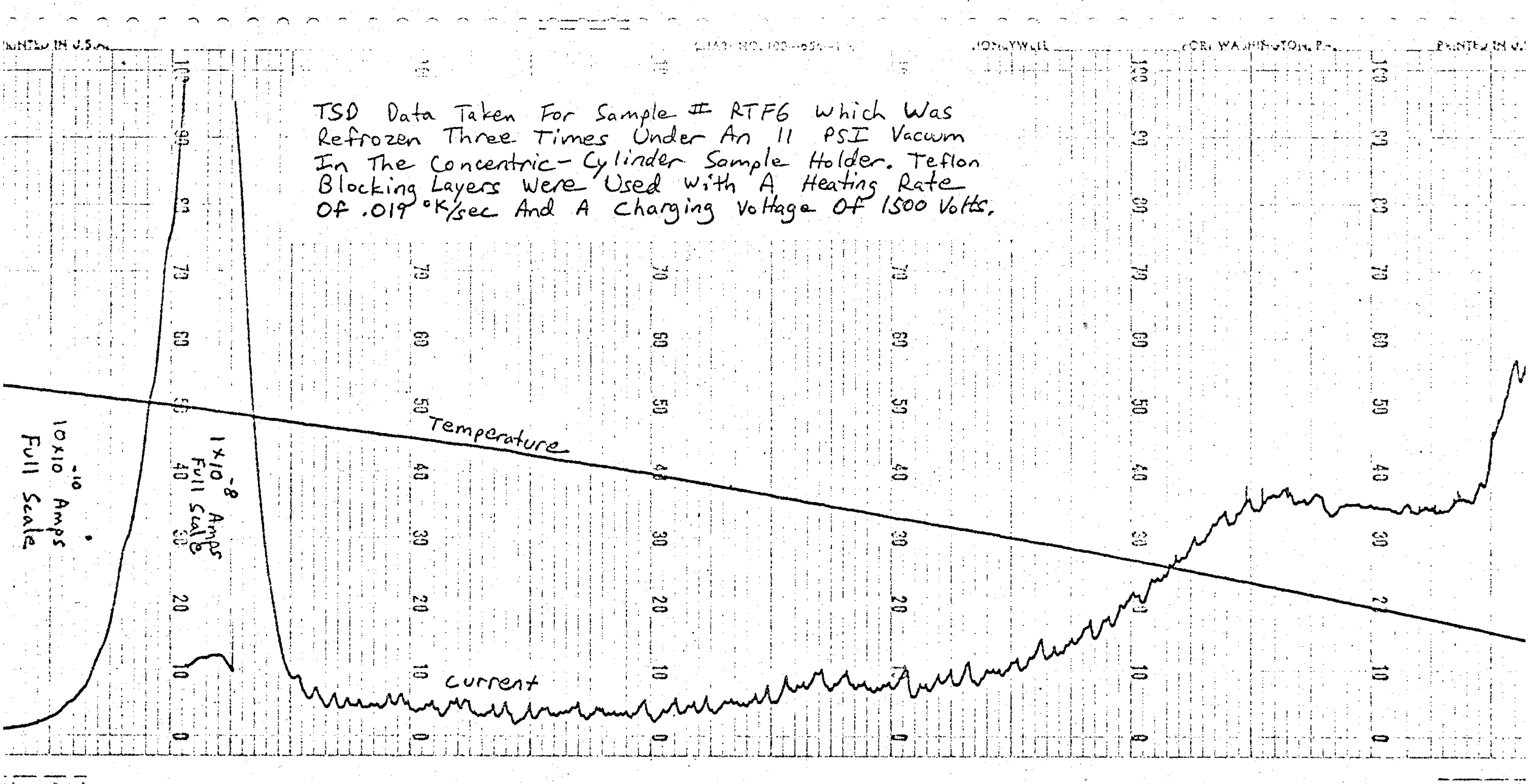

TSD Data Taken For Sample # RTF6 Which Was Refrozen Three Times Under An 11 PSI Vacuum In The Concentric-Cylinder Sample Holder. Teflon Blocking Layers Were Used With A Heating Rate Of .019 °K/sec And A Charging Voltage Of 1500 Volts.
Temperature
current
1×10^{-8} Amps Full Scale
10×10^{-10} Amps Full Scale

FIG. 10

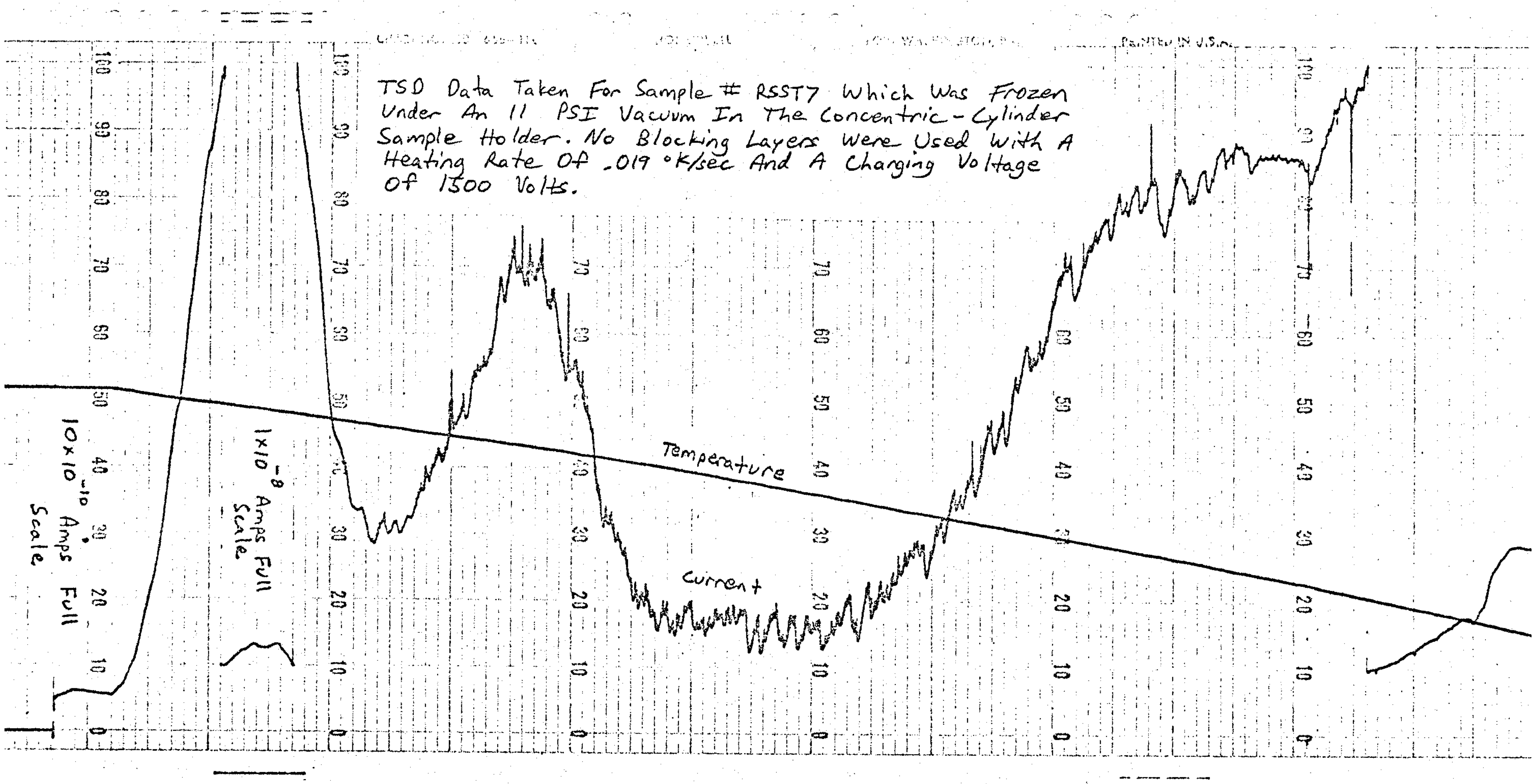

TSD Data Taken For Sample # RSST7 Which Was Frozen Under An 11 PSI Vacuum In The Concentric-Cylinder Sample Holder. No Blocking Layers Were Used With A Heating Rate Of .019 °K/sec And A Charging Voltage Of 1500 Volts.
Temperature
Current
1×10^{-8} Amps Full Scale
10×10^{-10} Amps Full Scale
PRINTED IN U.S.A.

FIG. 11

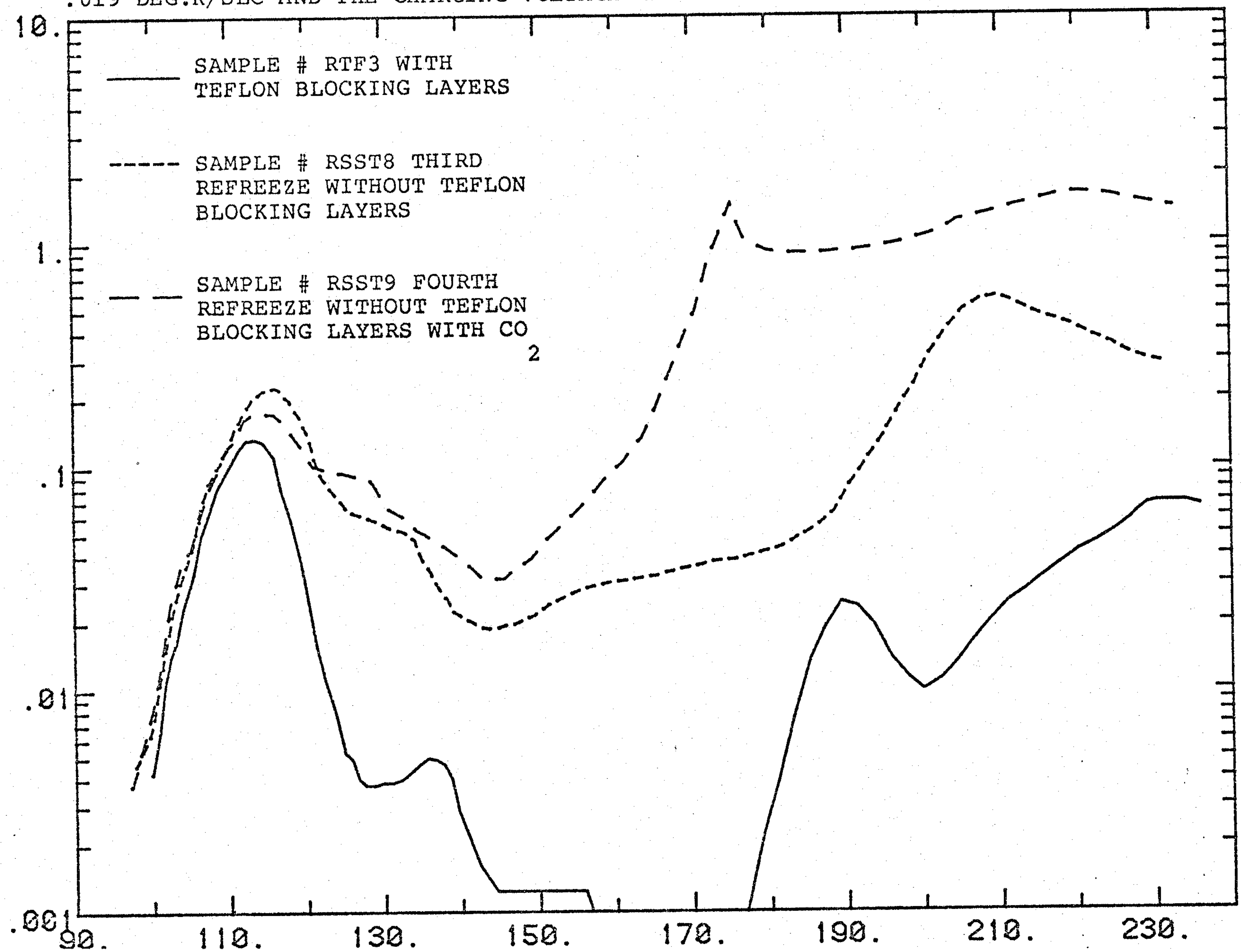
been smoothed out. It is interesting to note how bumpy the current line is after the coldest peak. There is a general trend for the current to be irregular like this between the first and third peaks. Since the concentric-cylinder sample holder has very good heat flow, these bumps are probably caused by the heaters pulsing and thus creating small temperature fluctuations. The flat-disk sample holder does not give a bumpy current probably because the heat flow is not good enough. It is certain that these irregularities are not electrical noise from the heaters because that has been observed before and looks much different.

Putting things in perspective, it is helpful to note how consistent the coldest peak in ice is. Figures 12 and 13 show how little the first peak changes when ice is refrozen under an 11 PSI vacuum, refrozen under carbon dioxide, or frozen with blocking layers. The rest of the TSD spectrum can really fluctuate but the first peak remains pretty stable.

5-DISCUSSION

Looking first at the coldest peak; it appears that L and D defects are the polarizing mechanisms for the following reasons. The first peak height is pretty consistent whether there are teflon blocking layers or not. This seems to indicate that the polarization is due to an intrinsic property of the ice and not electrode-ice surface interactions. A ferroelectric response seems unlikely because there is no TSD current without a polarizing electric field. The addition of carbon dioxide to the water does not increase the peak height, which seems to rule out H_3O^+ defects as being the cause of the

SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

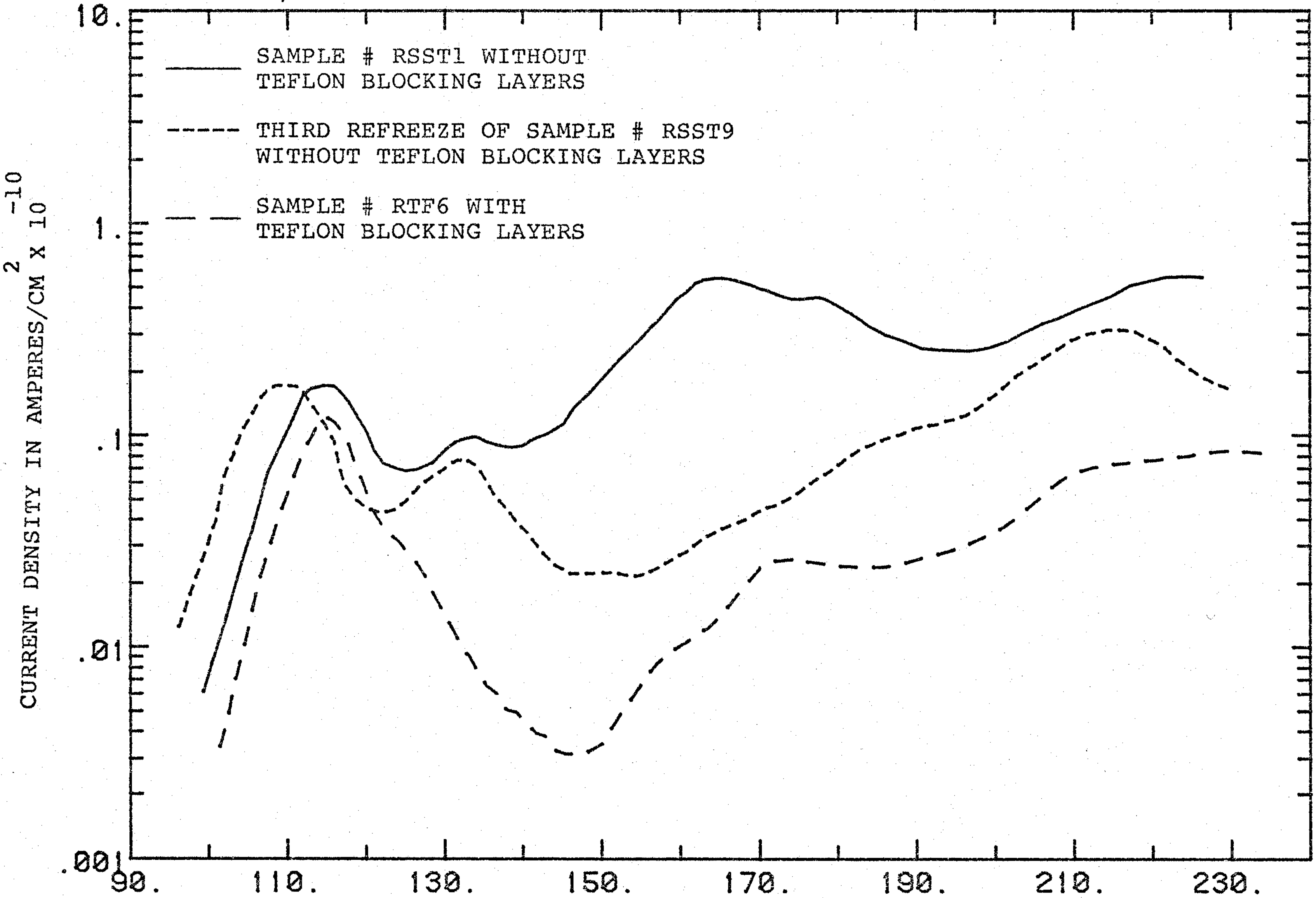


FIG. 13

polarization. The shift in peaks toward warmer temperatures when the heating rate is increased tends to support a relaxation process and discredit the idea of a thermodynamic phase transformation. Finally, the approximately linear increase in peak height with increasing charging field supports an ice volume polarization mechanism.

The work done by Johari and Jones on H_2O and D_2O ice, as mentioned in the introduction, gives strong evidence that the coldest peak is due to a relaxation of protons. The deuterons, being larger and heavier, take longer to relax than protons and thus give a warmer first peak. Johari and Jones also observed a shift in the first peak temperature toward warmer temperatures when the heating rate was increased.

It is interesting to notice what happens when Johari's heating rates and peak temperatures are substituted into equation (12). Table 8 shows the results of these calculations for Johari's data and this study's data. It seems that the greater the difference in in the two heating rates the smaller the calculated E; which says that the peak temperature does not increase linearly with increasing heating rate. This is also evident from the heating rate test plots shown in appendix IV. Also notice that the calculated E only agrees with small heating rates. This suggests that a smaller heating rate should be tried for this study to see if the activation energy increases.

The conclusion that H_3O^+ defects are not responsible for the first peak is supported by Chamberlain and Fletcher's work as mentioned in the introduction. They noticed no change in the

TABLE 8

Activation Energies Calculated From Equation (12)

Investigator	Heating Rates In °K/sec	Peak Temperatures In °K	Calculated E In cal/mole	difference in heating
Johari & Jones	2.28×10^{-3} 4.5×10^{-2}	110 132.5	3348	.043
Johari & Jones	2.28×10^{-3} 2.65×10^{-2}	110 123	4594	.024
Johari & Jones	2.28×10^{-3} 1.84×10^{-2}	110 114	12,518	.016
Clement	3.4×10^{-2} 9.0×10^{-3}	116.3 111.5	6659	.025
Clement	9.0×10^{-3} 1.9×10^{-2}	111.5 115.8	3992	.010

opposite to Johari's trend

first peak magnitude with varying concentrations of HF. This is assuming that acidic water produces ice with more H_3O^+ defects.

The second peak reacts in much the same way as the first peak, except that it is more inconsistent because it is in the temperature range of the positive and negative continuous discharge currents. These currents add and subtract from the peak thus making it hard to model. The first two peaks also seem to be interrelated. It was mentioned in the results that degassing of a sample decreases the second peak height and increases the first peak height. One possible explanation for this behavior is that the second peak is caused by L and or D defects being trapped by some impurity from dissolved gases. As the gas content is lowered, by refreezing under an 11 PSI vacuum, there are less impurities so the second peak height decreases and the first peak height increases. However, it has already been noted that dissolved carbon dioxide does not increase the second peak height, so some other gas may supply the trapping impurity.

Changes in the second peak height are probably responsible for the small temperature shifts of the first peak. It was mentioned in the results that the first peak shifts to a colder temperature after repeated refreezing. This is because the second peak height decreases, which results in a temperature decrease of the overlapping first peak. In addition to this, gas bubbles may hinder the diffusion of L and D defects and thus lengthen the time for relaxation to take place.

The area of the TSD spectrum between the second and third peaks is difficult to draw any conclusions about because it is so inconsistent. More work needs to be done to find out what causes the positive discharge current that is so apparent when no blocking layers are used. This continuous current distorts the shape of the second and third peaks and really makes the third peak too difficult to work with. It is this continuous positive discharge current that is the major contributor to the dielectric constant. Thus it is important to know if this current is caused by an intrinsic property of the ice.

Superposed over this positive heterocharge current is the negative homocharge current that is most visible when blocking layers are used. This homocharge is probably caused by electrons being injected into the ice at the electrode-ice surface. Teflon blocking layers prevent the homocharges from recombining with image charges on the electrodes, so the homocharges must recombine in the ice to give a negative current. Since electrons are much more mobile than protons, they are able to react to small scale temperature fluctuations. This may be the cause of the bumpy current line mentioned in the results. When no blocking layers are used most of the homocharges recombine with image charges on the electrodes, which reduces the negative current and makes the positive current more visible.

It is difficult to imagine how the ice-electrode interface can be any more perfect since the ice is frozen in the sample holder. So if the homocharge current is caused by Townsend breakdown in the supposed air gap between the electrode and ice, it is probably due to the ice shrinking away from the sample holder walls during cooling.

Almost as inconsistent as the area between the second and third peaks is the third peak itself. It is variable in both peak height and peak temperature between different samples, but is always there. The fact that the third peak height increases when carbon dioxide is frozen into the ice could indicate that this third peak has ionic defects, such as H_3O^+, as its polarization mechanism. This is consistent with the results of Mascarenhas and Arguello. They found that the third peak height increased as the HF concentration was increased. It is too bad that the third peak is so interfered with that it can't be modeled. If a way could be found to eliminate the positive and negative continuous currents then more progress could be made on the warmest peak.

A review of the previous works mentioned in the introduction shows that the first peak temperature ranges from 100 deg.K to 125 deg.K depending on which author is presenting the results. This variability is most certainly due to the different apparatuses used. Previous works done in this laboratory reported the first peak temperature, with blocking layers, as 125 deg.K instead of 109.8 deg.K, just because a different sample holder was used. 109.8 deg.K is more accurate because the temperature monitoring thermocouple was frozen into the ice and not inserted into a hole in the electrode. Previously the first two peaks' parameters were reported as $E=.721 \times 10^{4}$ cal/mole and $\gamma_o=.350 \times 10^{-10}$ sec for the first peak, and $E=.824 \times 10^{4}$ cal/mole and $\gamma_o=.500 \times 10^{-11}$ sec for the second peak. Now, by using the concentric-cylinder sample holder, they are $E=.601 \times 10^{4}$ cal/mole and $\gamma_o=.234 \times 10^{-9}$ sec for the first peak, and $E=.532 \times 10^{4}$ cal/mole and $\gamma_o= .204 \times 10^{-7}$ sec for the second peak. Another difference between the previous flat-disk sample holder data and the new concentric-cylinder sample holder data is that the previously reported 155 deg.K peak is now gone. This may have been a phantom peak caused by poor heat flow.

There is a big discrepancy between the E and γ_o reported in this study, and the E and γ_o reported by Johari and Jones as can be seen in table 7. They give an E twice as big and a γ_o 10 orders of magnitude smaller than this study reports. Figures 13A and 13B illustrate what Johari's reported parameters give compared to typical TSD plots collected at this laboratory. The difference seems to be that Johari and Jones apply some peak cleaning method to their data before they model it. They eliminate a bulge on the rising side of the first peak and eliminate the effects of the second peak to arrive at some idealized data. This may or may not be a valid procedure depending on whether the first peak has a discrete E or a distributed E. In any case the E and γ_o, calculated in this study, may be more an average set of parameters for the first peak complex than a discrete set of parameters for the first peak.

The discrepancy mentioned above brings to mind a possible improvement in the TSD modeling procedure. The inversion program used in this study looks at all the data points that comprise each peak. Perhaps it would be better to develop a program that only looks at a few points around the peak top, where the bulge on the rising side, and the second peak, have less influence over the data than the major first peak mechanism. This method would probably give results more in line with Johari's. If only the peak top is modeled

TABLE 7

COMPARISON OF PEAK PARAMETERS FROM DIFFERENT STUDIES

	Johari	Will - flat disk sample holder	Clement - concentric cylinder sample holder
ak Temperature in cal/mole in sec	110 °K 11300 5×10^{-20}	125 °K 7210 35×10^{-12}	109 °K 6010 2×10^{-10}
ak Temperature in cal/mole in sec	159 °K — —	140 °K 8240 5×10^{-12}	136 °K 5320 2×10^{-8}
ak Temperature in cal/mole in sec	233 °K — —	155 °K 9890 0.1×10^{-12}	218 – 230 — —
ak Temperature in cal/mole in sec	— — —	190 °K — —	— — —

A LINEAR PLOT THAT COMPARES A TSD RUN, DONE WITH SAMPLE # RSST11 REFROZEN THREE TIMES UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER, TO A TSD PEAK CALCULATED USING JOHARI'S PARAMETERS E=11300 CAL/MOLE AND TAU ZERO=5.E-20 SEC.

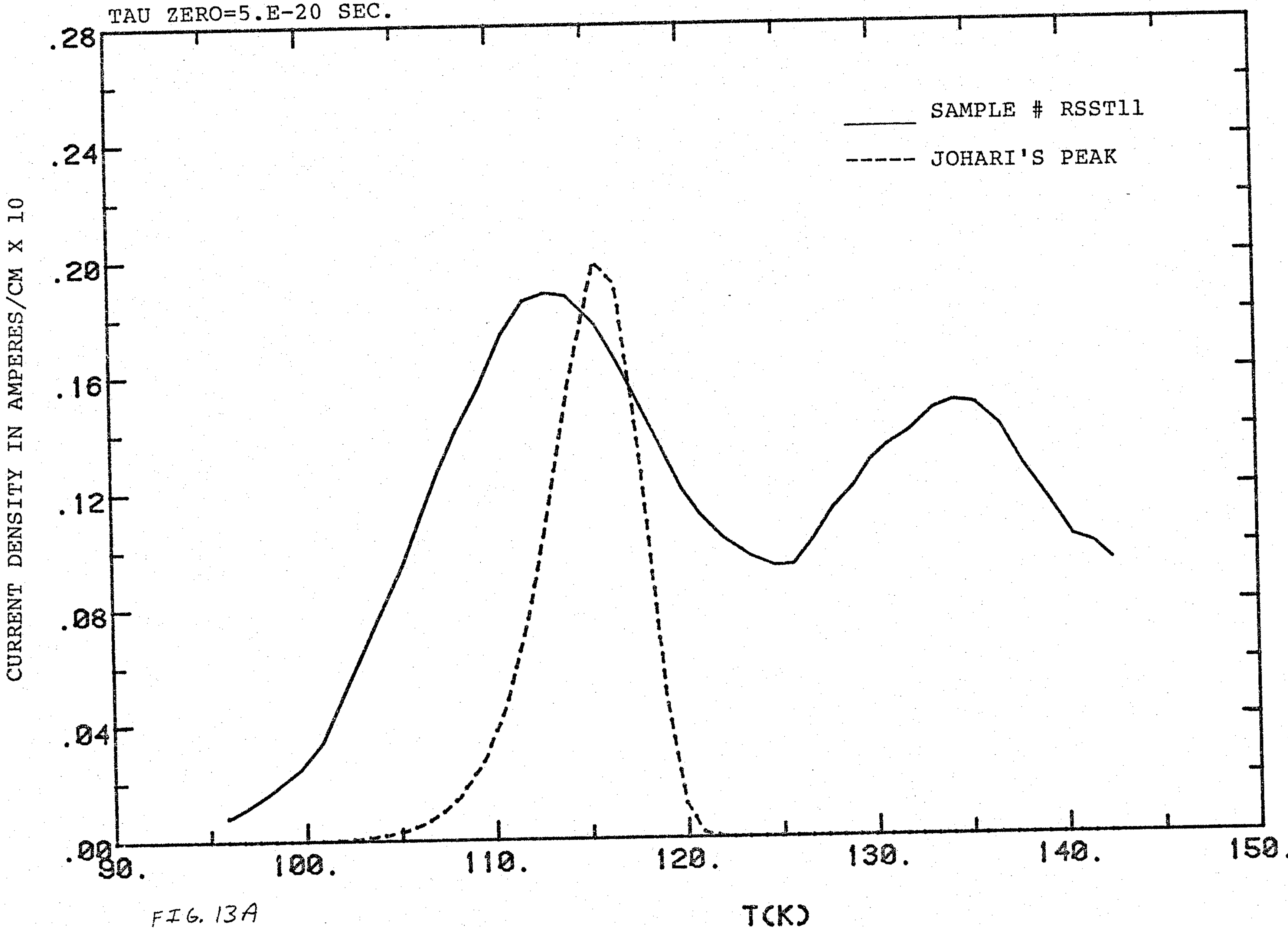


FIG. 13A

A LINEAR PLOT THAT COMPARES A TSD RUN, DONE WITH SAMPLE # RTF5 REFROZEN THREE TIMES UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER, TO A TSD PEAK CALCULATED USING JOHARI'S PARAMETERS E=11300 CAL/MOLE AND TAU ZERO=5.E-20 SEC.

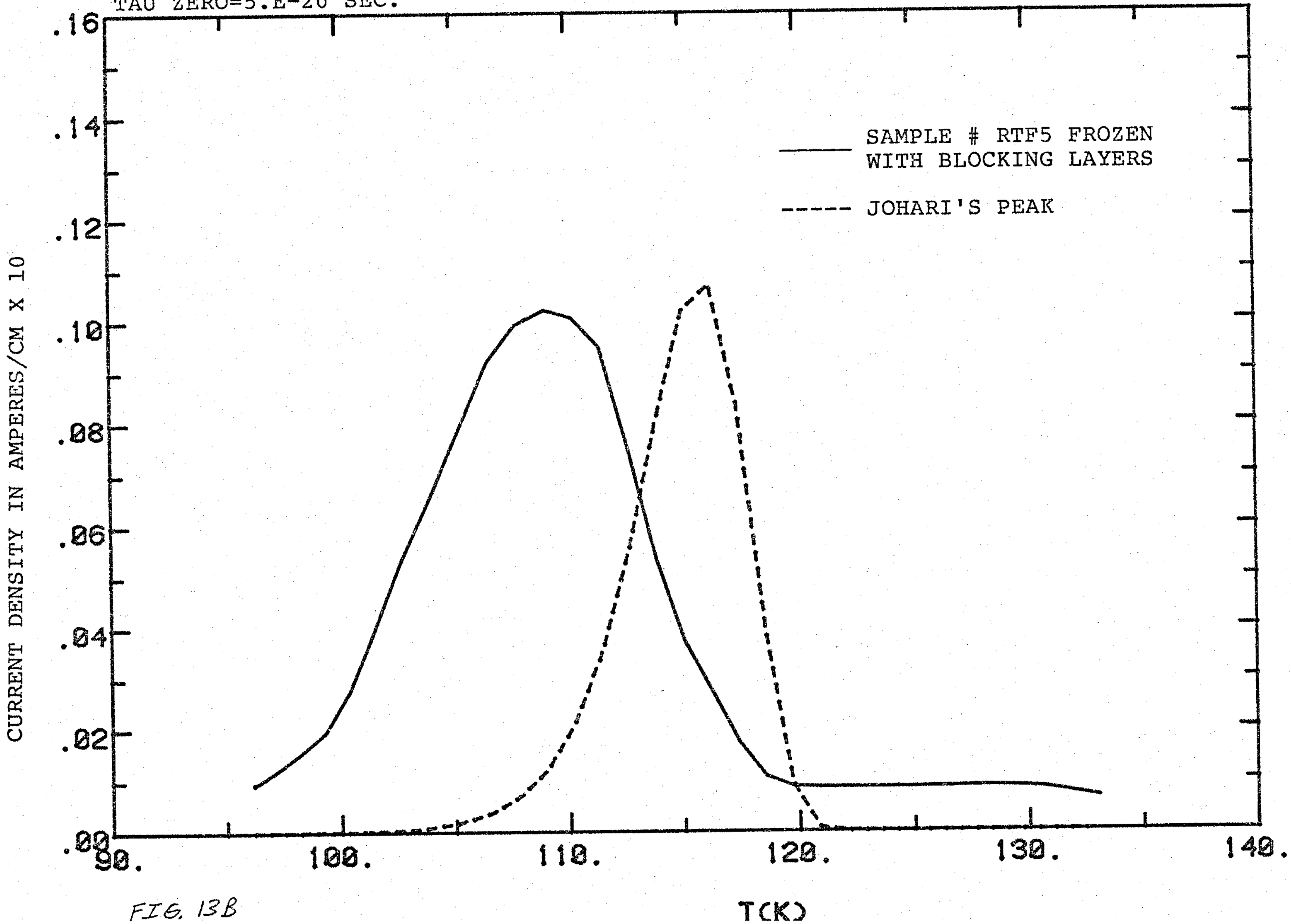


FIG. 13B

then the heater fluctuations should be smoothed out to give a smooth first peak, and good resolution.

6-CONCLUSIONS

In brief, it seems pretty certain that the 109.8 deg.K peak in pure ice is caused by the relaxation of L and D defect dipoles. An estimate of this peak's parameters is $E=.601 \times 10^{4}$ cal/mole and $\tau_{o}=.234 \times 10^{-9}$ sec. It is uncertain whether this peak should be represented by a discrete or a distributed set of parameters; however, the low value of E calculated in this study does indicate that a distributed set of parameters is possibly more correct.

The 136.3 deg.K peak may be caused by L and or D defects being trapped by impurities from dissolved gasses. An estimate of its peak parameters is $E=.532 \times 10^{4}$ cal/mole and $\tau_{o}=.204 \times 10^{-7}$ sec. Much more work needs to be done on this second peak before this is a firm conclusion.

The warmest peak may be due or partly due to H_3O^+ defects. Because this peak is so broad and inconsistent it is thought that space charge relaxation may also contribute to it. Its peak temperature ranges from 218 to 230 deg.K depending on the freezing conditions and what other current is interfering with it.

Ice also exhibits some continuous currents, primarily located between the second and third peaks. When Teflon blocking layers are used a homocharge current is visible, and when no blocking layers are used a continuous heterocharge current is visible. Both currents are probably due to electrode-ice surface interactions.

7-SUGGESTIONS FOR FUTURE WORK

This author believes that the polarization mechanism responsible for the coldest TSD peak has been pretty well determined, however it remains to be seen if the first peak's parameters agree with the theoretical estimates of parameters for L and D defects. The answer to that question should give some insight into whether there are really more peaks that make up the first peak, whether there is thermal broadening, or does the first peak really have a distributed parameter set.

More TSD runs, using the concentric-cylinder sample holder with and without blocking layers, need to be done with different gases such as carbon dioxide, nitrogen and oxygen. The results of these tests should help to verify or discredit the hypothesis that the second peak is caused by L and or D defects being trapped by a gas impurity. Also if the second peak can be enhanced then better peak parameters can be obtained for it. These tests would require that a second valve be put on the freezing apparatus for exhausting the existing gases out from under the bell jar. TSD runs done with different gases may also provide some clue as to what causes the continuous positive discharge current between the second and third peaks. This current is such a large portion of the dielectric constant that it is important to understand it.

Some improvements need to be made on the teflon blocking layers used with the concentric-cylinder sample holder. They are difficult to remove once they are in the sample holder, and it is too easy to get moisture trapped between the blocking layer and stainless-steel wall of the sample holder.

The TSD modeling program could be greatly improved. The first peak should be modeled at its maximum where the second peak, and bulge on the rising side of the first peak, have their least influence. This means that only a few data points around the peak maximum need be considered. Once parameters for the first peak are calculated more data points are included in the model so that the second peak's parameters can be calculated.

This modeling procedure is good for discrete parameter set peaks but would not be good for a distributed parameter set peak. In the latter case the inversion program could be rewritten to include a distributed E or γ_o.

In both cases attention should be paid to minimizing the time and cost required to use the modeling program. For instance, if the current density at one point is divided by the current density at the next point, P_o is eliminated from the equations. This leads to smaller matrices and less computational time. A different modeling scheme (possibly Newton's Method) would probably give a better estimate of γ_o.

If a limited number of data points are used, say around a peak top, then the current density line should be smoothed out. Because only a few data points are used for the model, sources of error, such as heater fluctuations, must be limited. It should be possible to accomplish this by experimenting with different combinations of heating rate and controller thermocouple placement. It would be nice if this were done in any case. At present there are some fluctuations in the current density line because the heaters tend to over-shoot the controller, and then wait for it to catch up.

8-ACKNOWLEDGMENTS

I would like to thank my advisor Dr. Gerardo W. Gross for his patience and support in allowing me to work on this project.

9-REFERENCES

1. J. van Turnhout, Thermally Stimulated Discharge of Polymer Electrets, Elsevier Scientific Publishing Company, p.1 (1975).

2. G.P. Johari and S.J. Jones, J. Chem. Phys, 62, p.4213-4223 (1975).

3. P. Pissis, L. Apekis and G. Boudouris, Il Nuovo Cimento, 62B, p.365-373 (1981).

4. J.S. Chamberlain and N.H. Fletcher, Phys. Kondens. Materie, 12, p.193-209 (1971).

5. O. Dengal, U. Eckener, H. Plitz and N. Riehl, Phys. Letters, 9, p.291-292 (1964).

6. C. Kittel, Introduction To Solid State Physics, Wiley and Sons, p.182 (1959).

7. S. Mascarenhas and C. Arguello, J. Electrochem. Soc. 115, p.386 (1968).

8. R. Will, A report entitled "Theory And Analysis Of Thermally Stimulated Discharge Currents In Pure Ice," New Mexico Institute Of Mining and Technology, Socorro, New Mexico (1981).

9. C. Jaccard, Annals of The New York Academy of Sciences, 125, Article 2, p.392 (1965).

10. C. Jaccard, Annals of The New York Academy of Sciences, 125, Article 2, p.392 (1965).

11. J. van Turnhout, Thermally Stimulated Discharge Of Polymer Electrets, Elsevier Scientific Publishing Company, p.3 (1975).

12. J. van Turnhout, Thermally Stimulated Discharge Of Polymer Electrets, Elsevier Scientific Publishing Company, p.31

(1975).

13. J. van Turnhout, Thermally Stimulated Discharge Of Polymer Electrets, Elsevier Scientific Publishing Company, p.33 (1975).

14. J. van Turnhout, Thermally Stimulated Discharge Of Polymer Electrets, Elsevier Scientific Publishing Company, p.31 (1975).

15. J. van Turnhout, Thermally Stimulated Discharge Of Polymer Electrets, Elsevier Scientific Publishing Company, p.34 (1975).

16. P. V. Hobbs, Ice Physics, Oxford University Press, p.90-91 (1974).

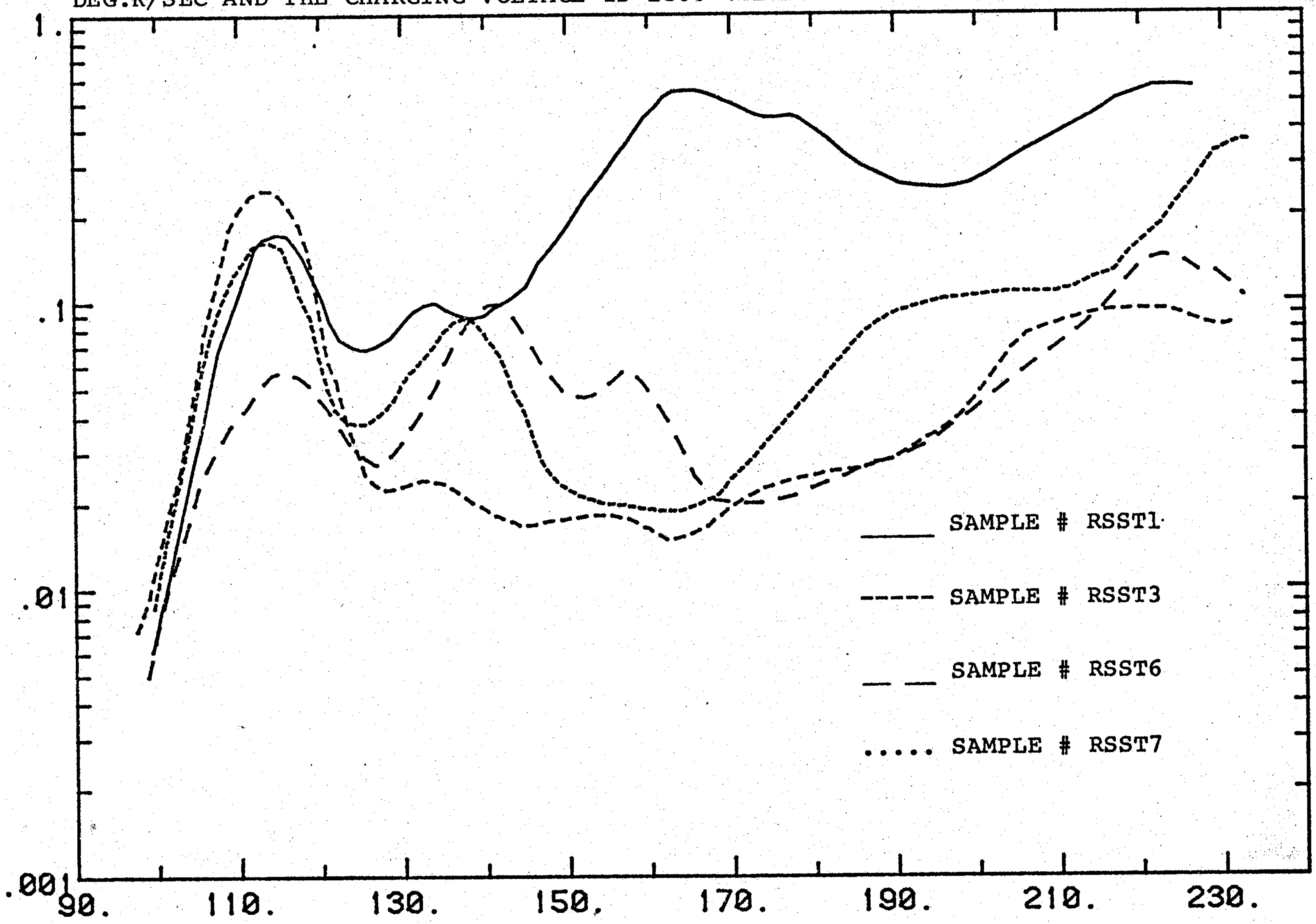
17. G.P. Johari and S.J. Jones, J. Chem. Phys, 62, p.4213-4223 (p.14), (1975).

18. J. van Turnhout, Thermally Stimulated Discharge Of Polymer Electrets, Elsevier Scientific Publishing Company, p.36-37 (1975).

APPENDIX I-MISCELLANEOUS TSD PLOTS

THIS APPENDIX CONTAINS ASSORTED TSD PLOTS THAT DON'T FIT INTO OTHER APPENDICES BUT ARE NEEDED TO COMPARE RUNS OF DIFFERENT SAMPLES AND GET TOTAL CUMULATIVE CHARGE DATA.

SEMI-LOG PLOT OF TSD RUNS, OF DIFFERENT SAMPLES FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, FOR DIFFERENT SAMPLES FROZEN IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER UNDER AN 11 PSI VACUUM. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

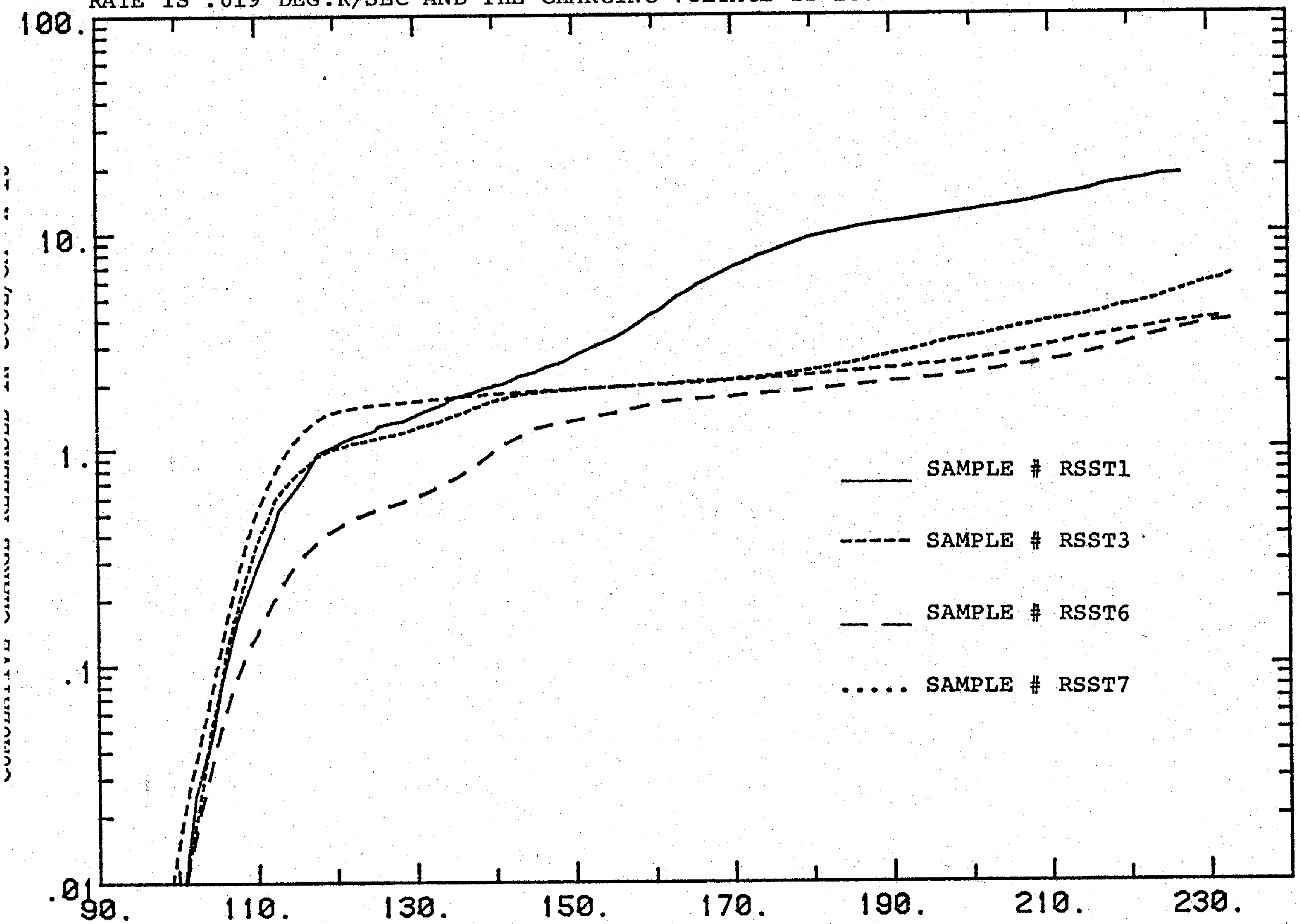


FIG. 15

SEMI-LOG PLOT OF TSD RUNS, OF DIFFERENT SAMPLES FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

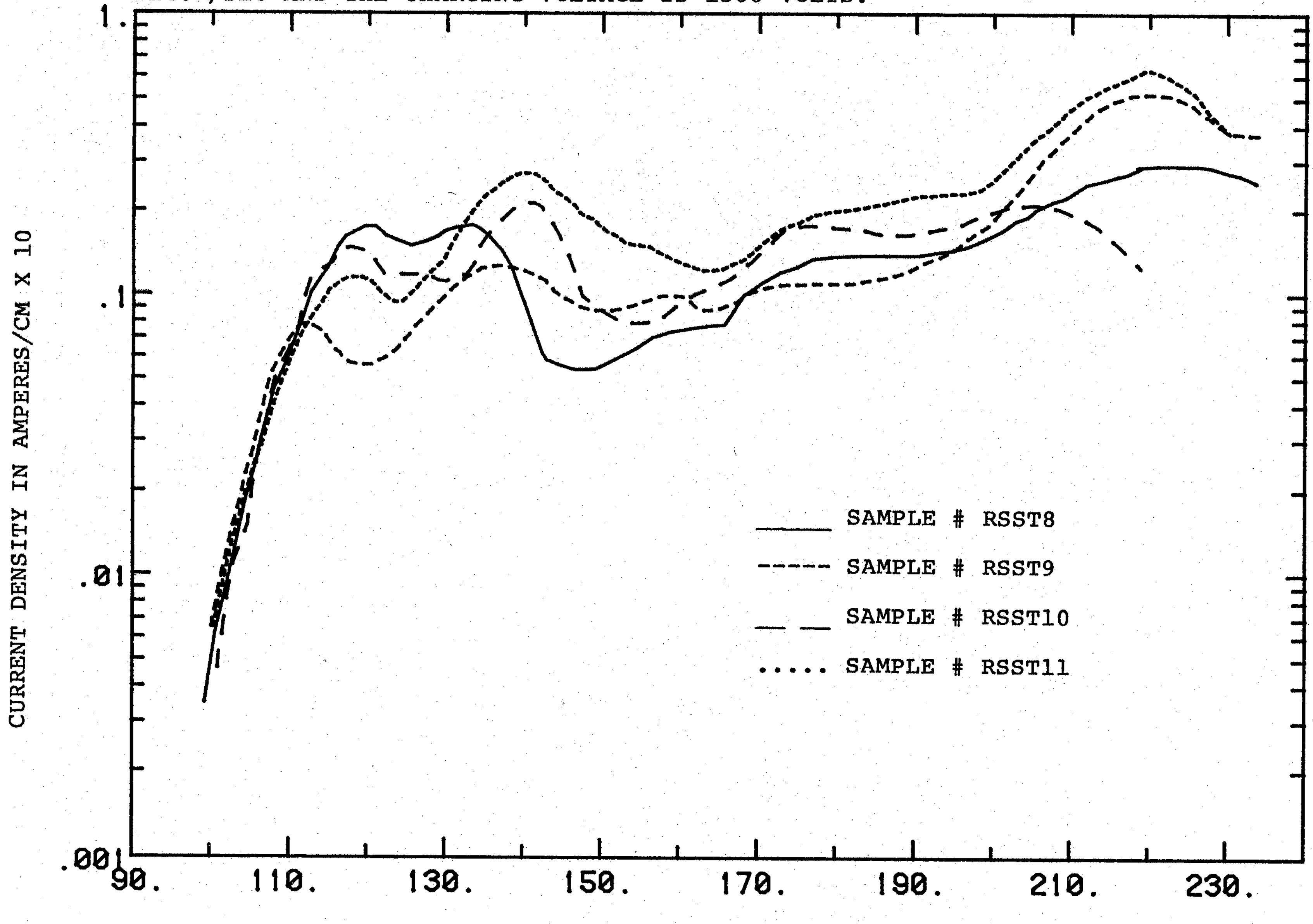


FIG. 16

SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, FOR DIFFERENT SAMPLES FROZEN IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER UNDER AN 11 PSI VACUUM. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

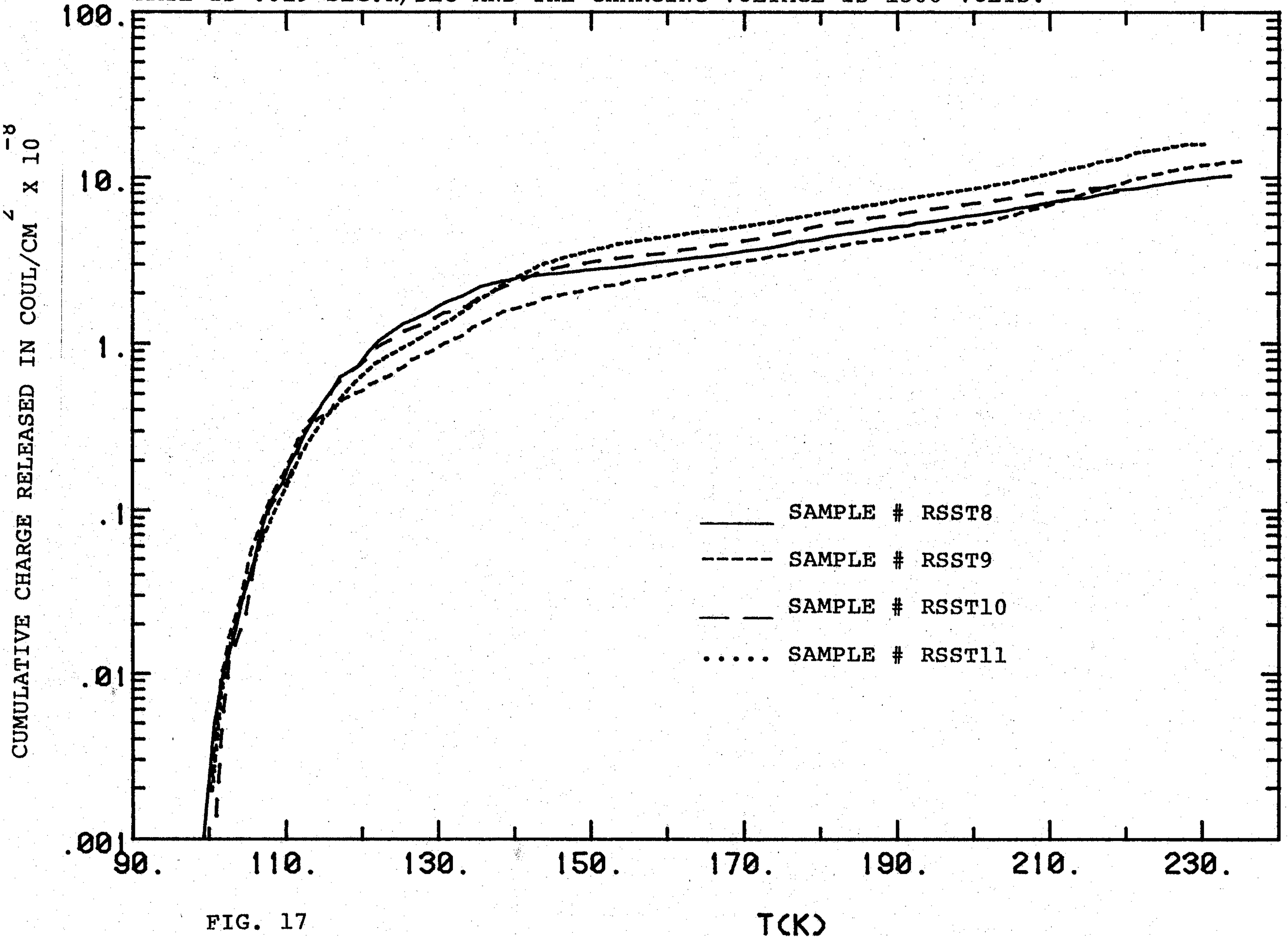
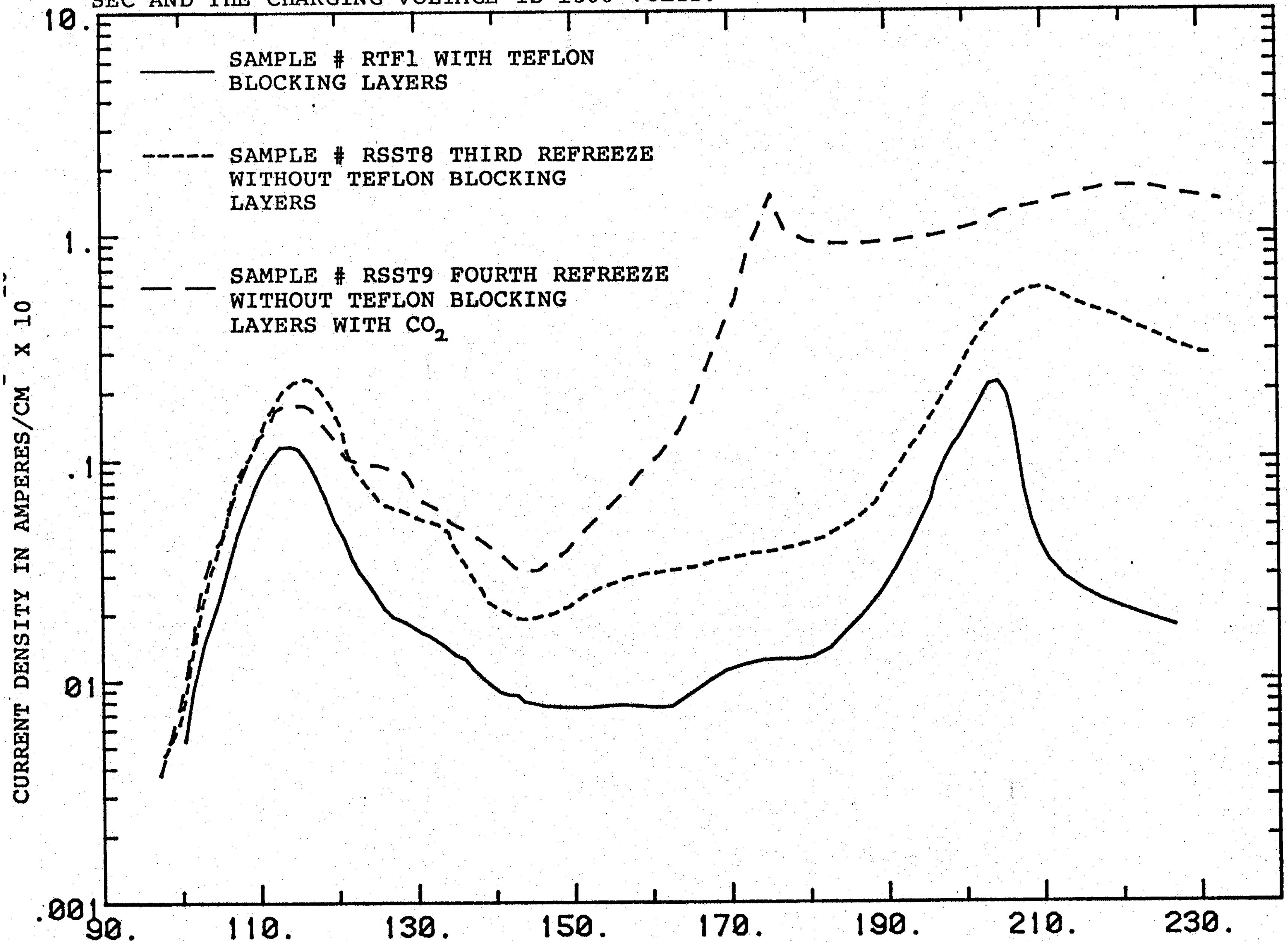


FIG. 17

SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

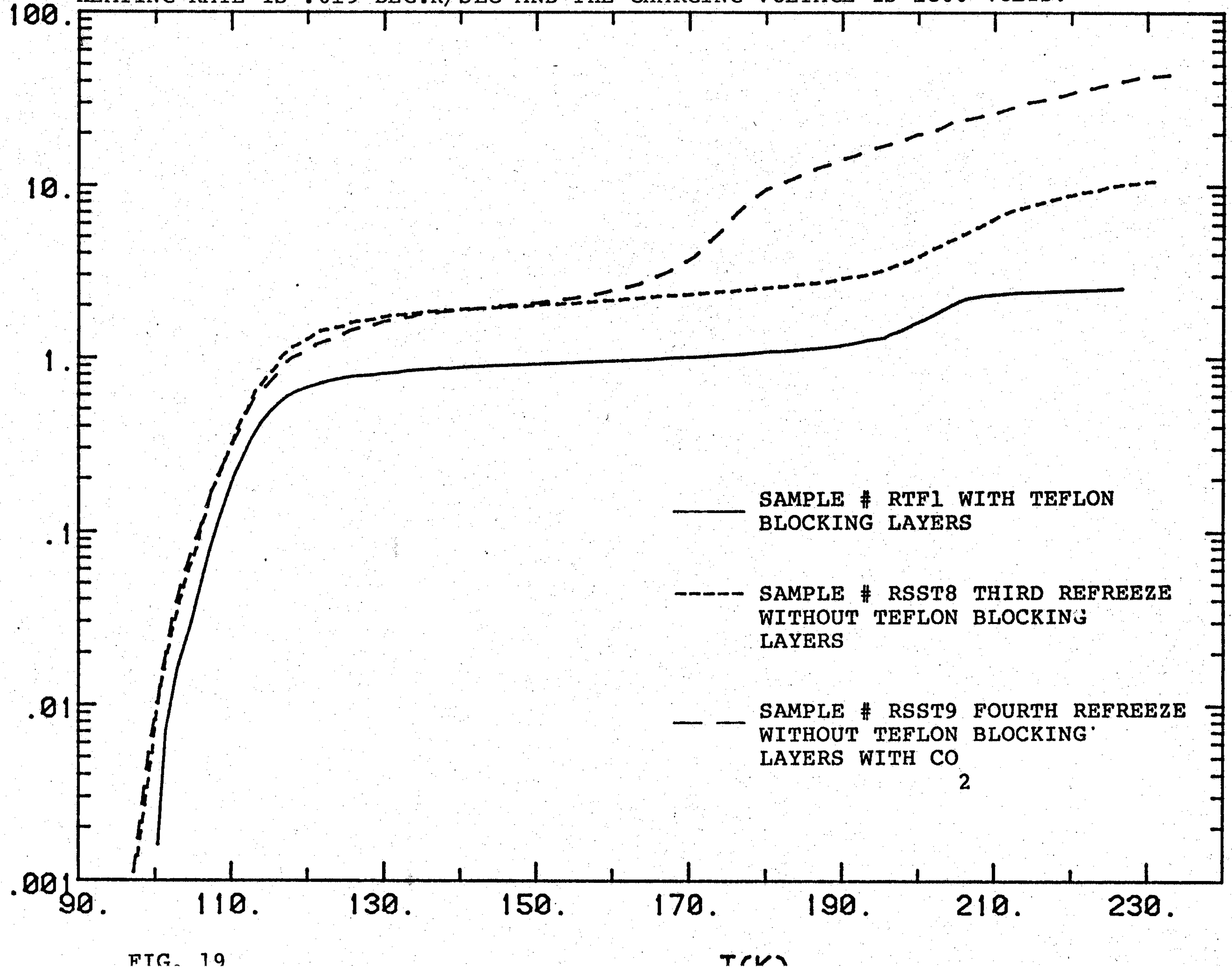
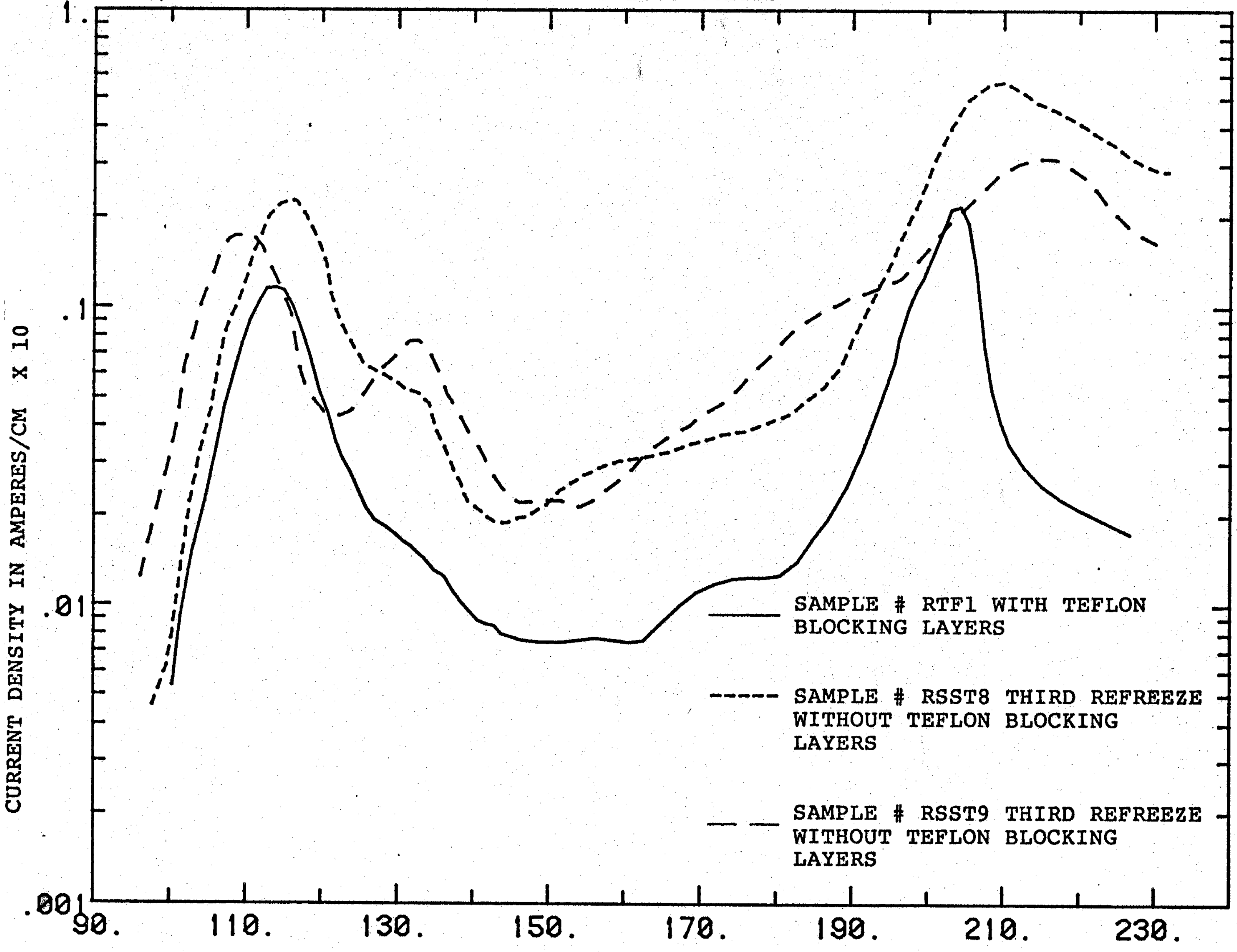
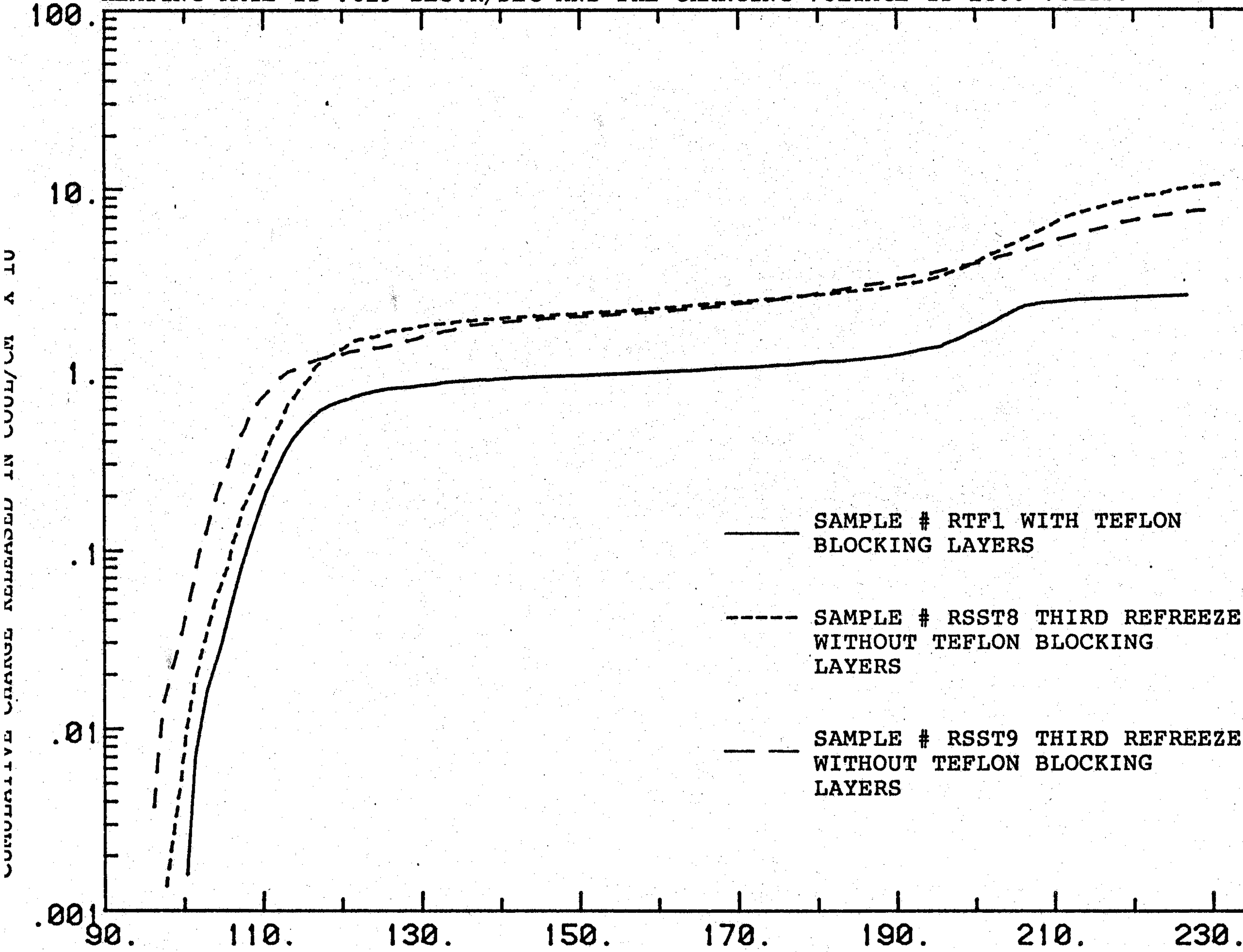


FIG. 19

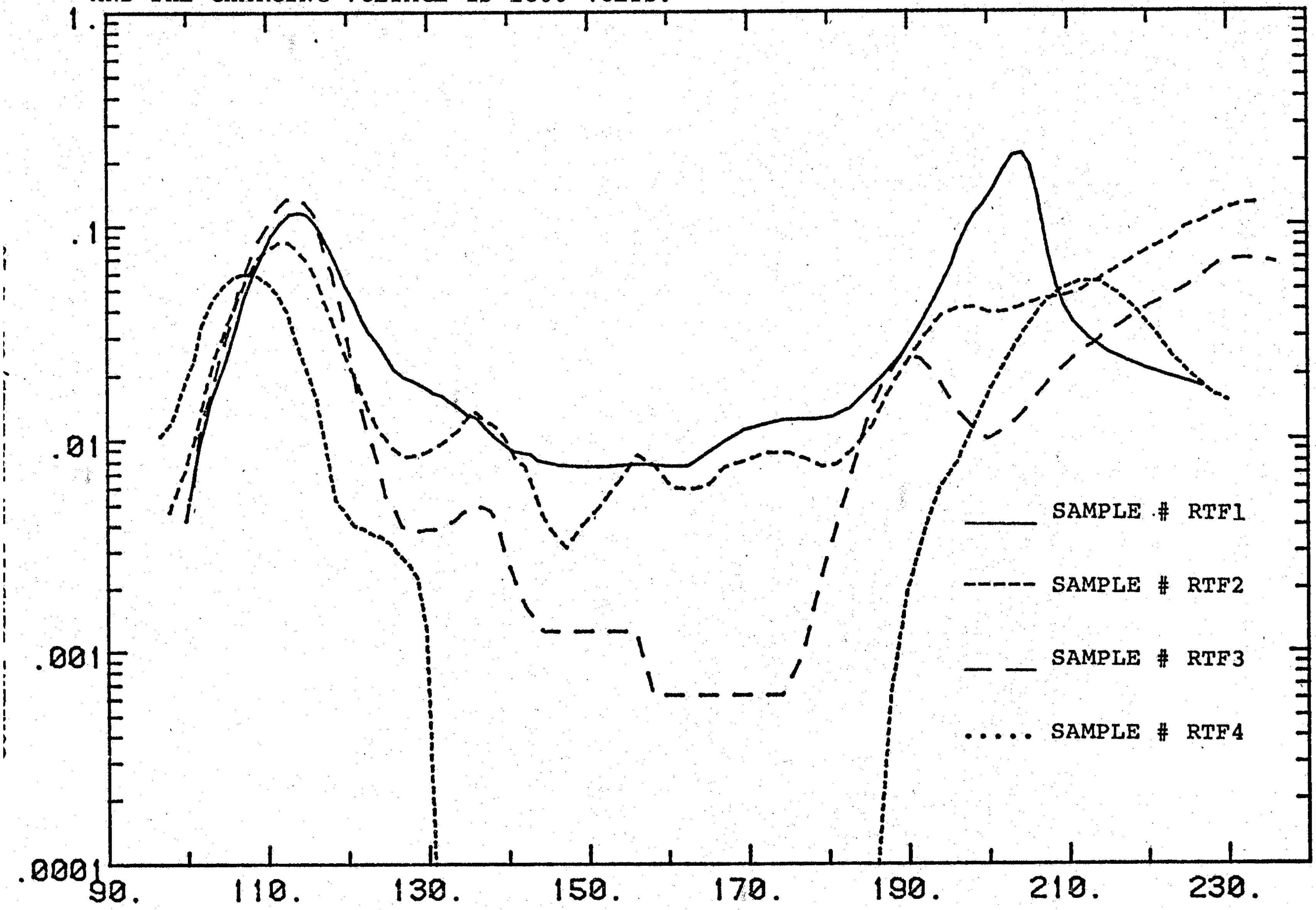
SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



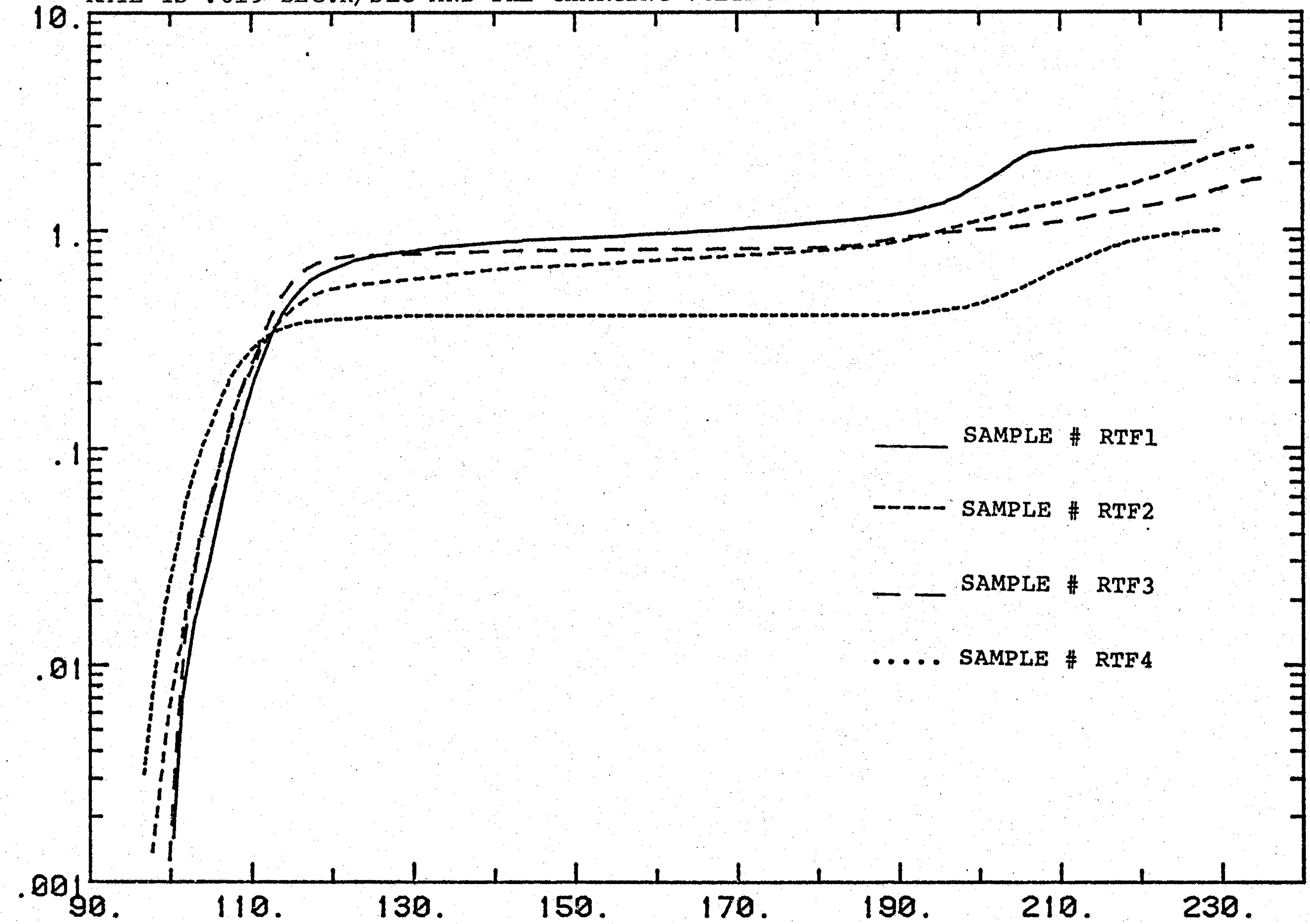
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF SAMPLES WITH AND WITHOUT TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF SAMPLES WITH TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.



SEMI-LOG PLOT OF TSD RUNS, OF SAMPLES WITH TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

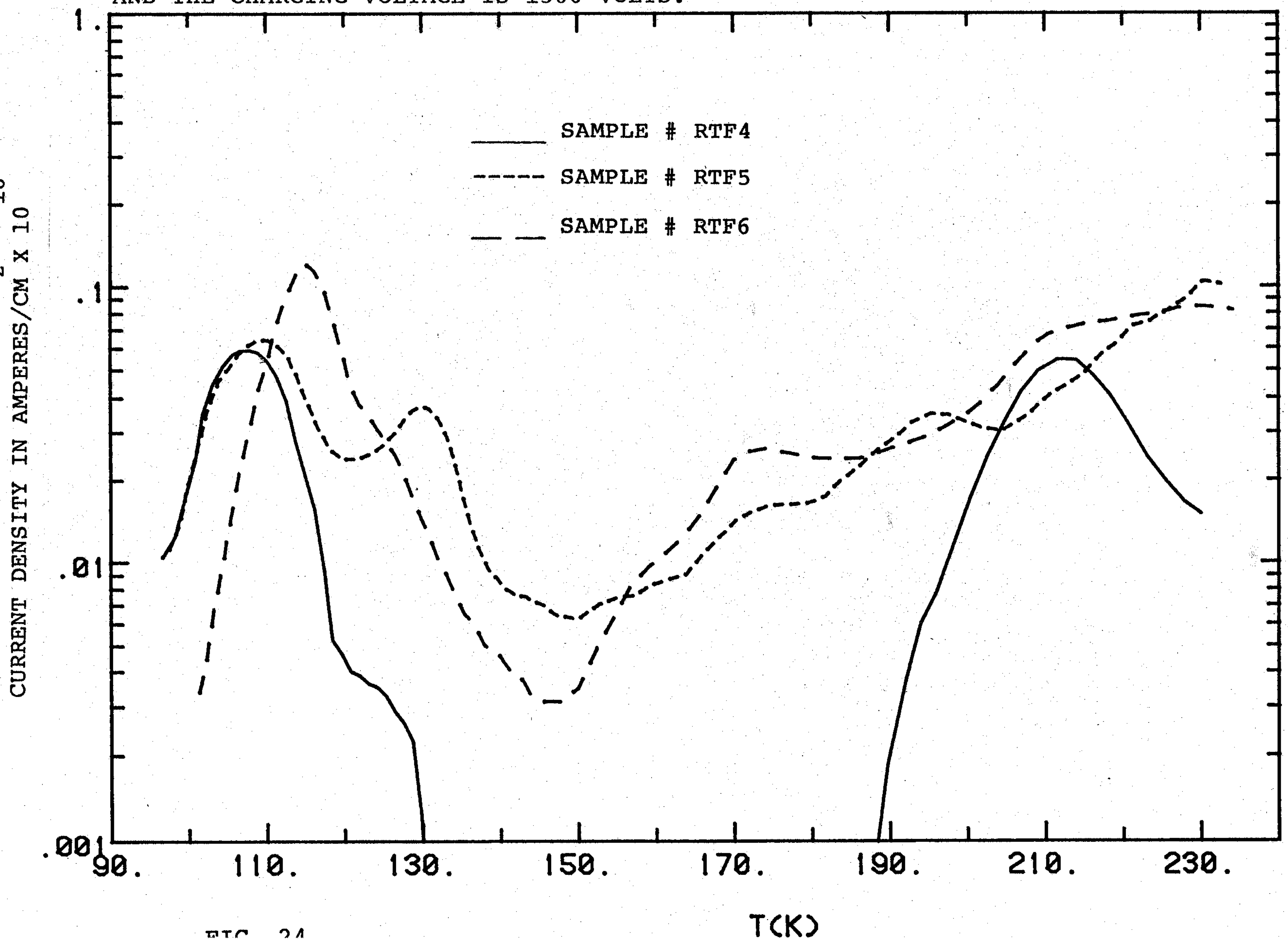


FIG. 24

SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED OF SAMPLES WITH TEFLON BLOCKING LAYERS USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE CHARGING VOLTAGE IS 1500 VOLTS.

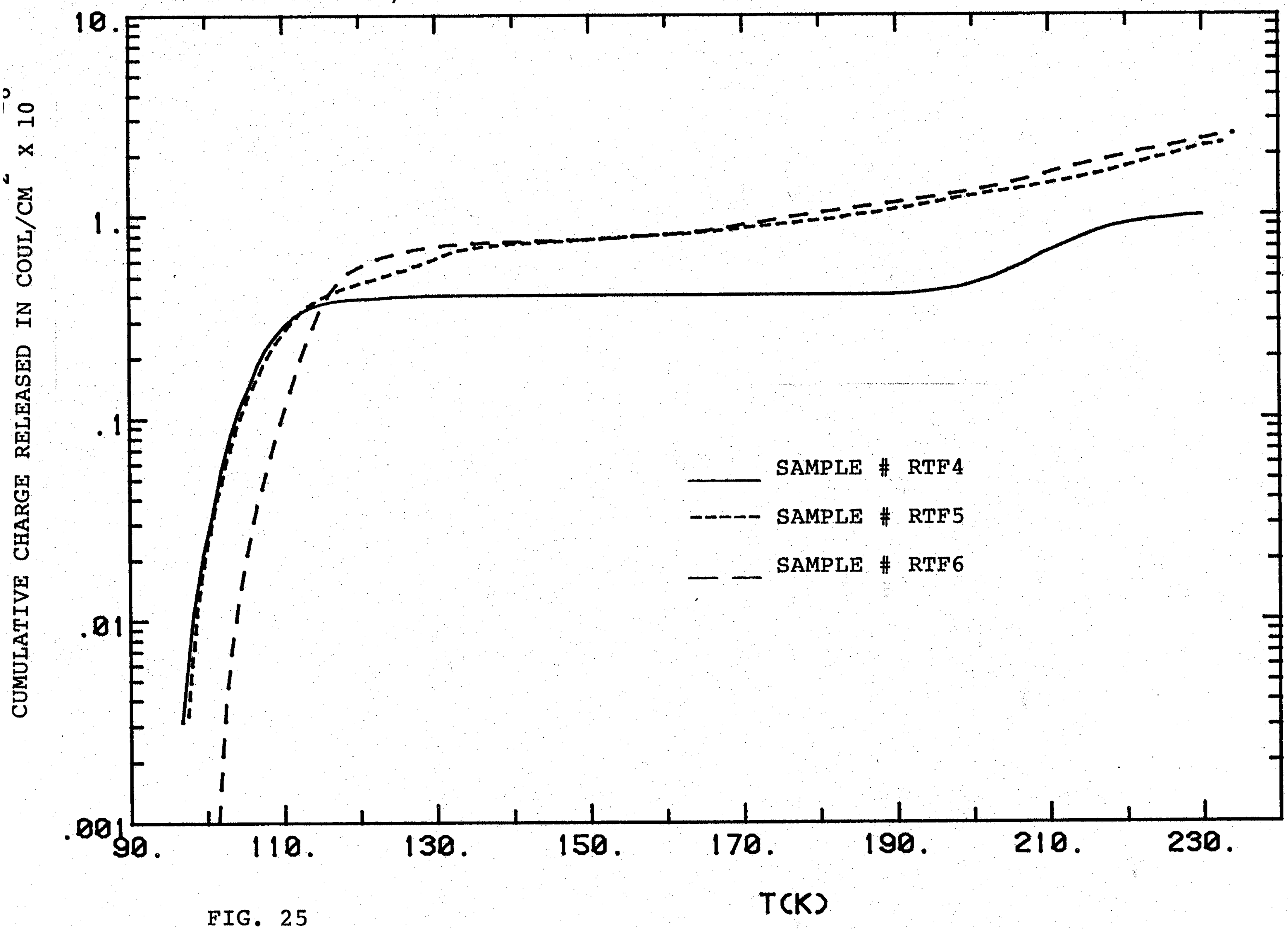
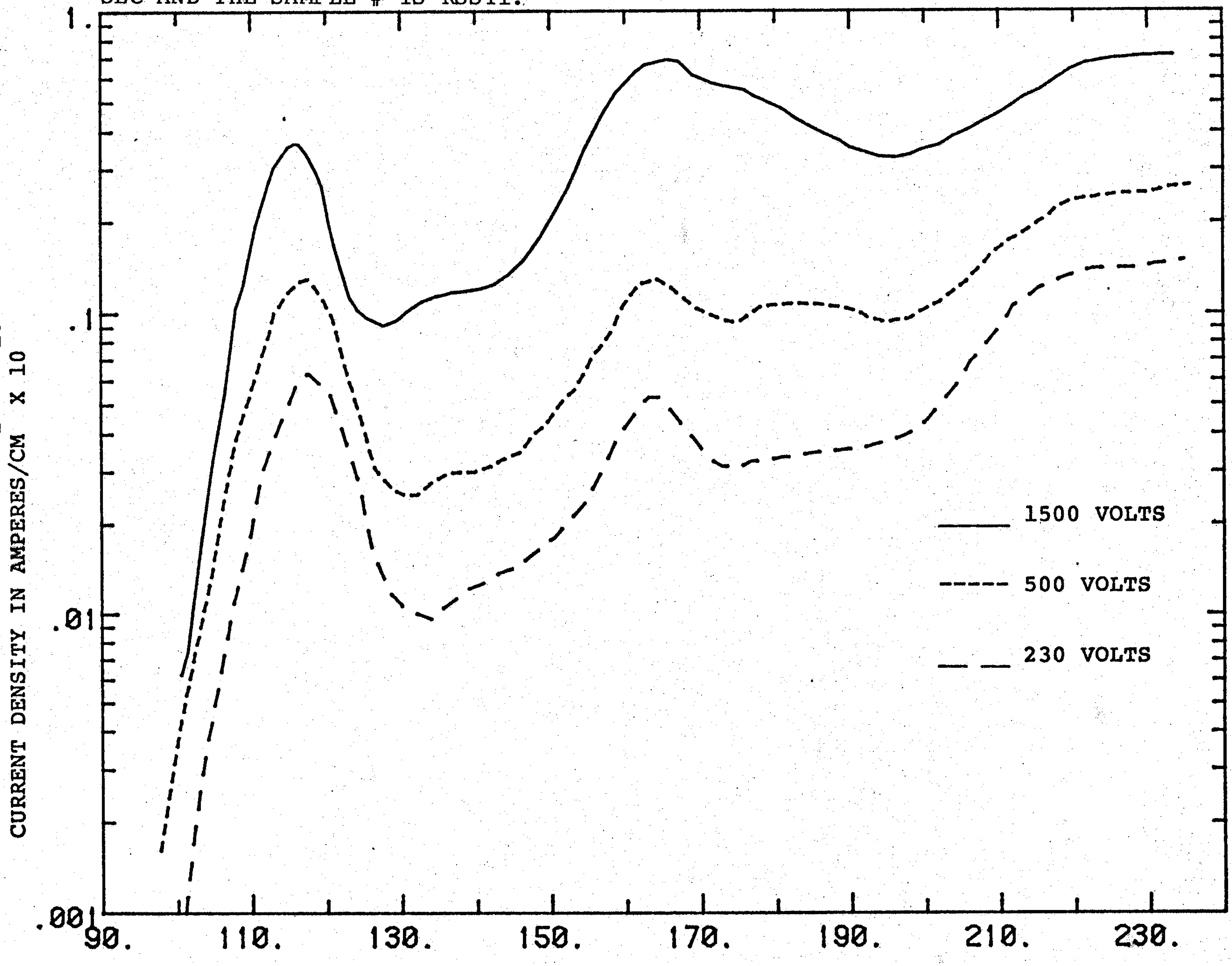


FIG. 25

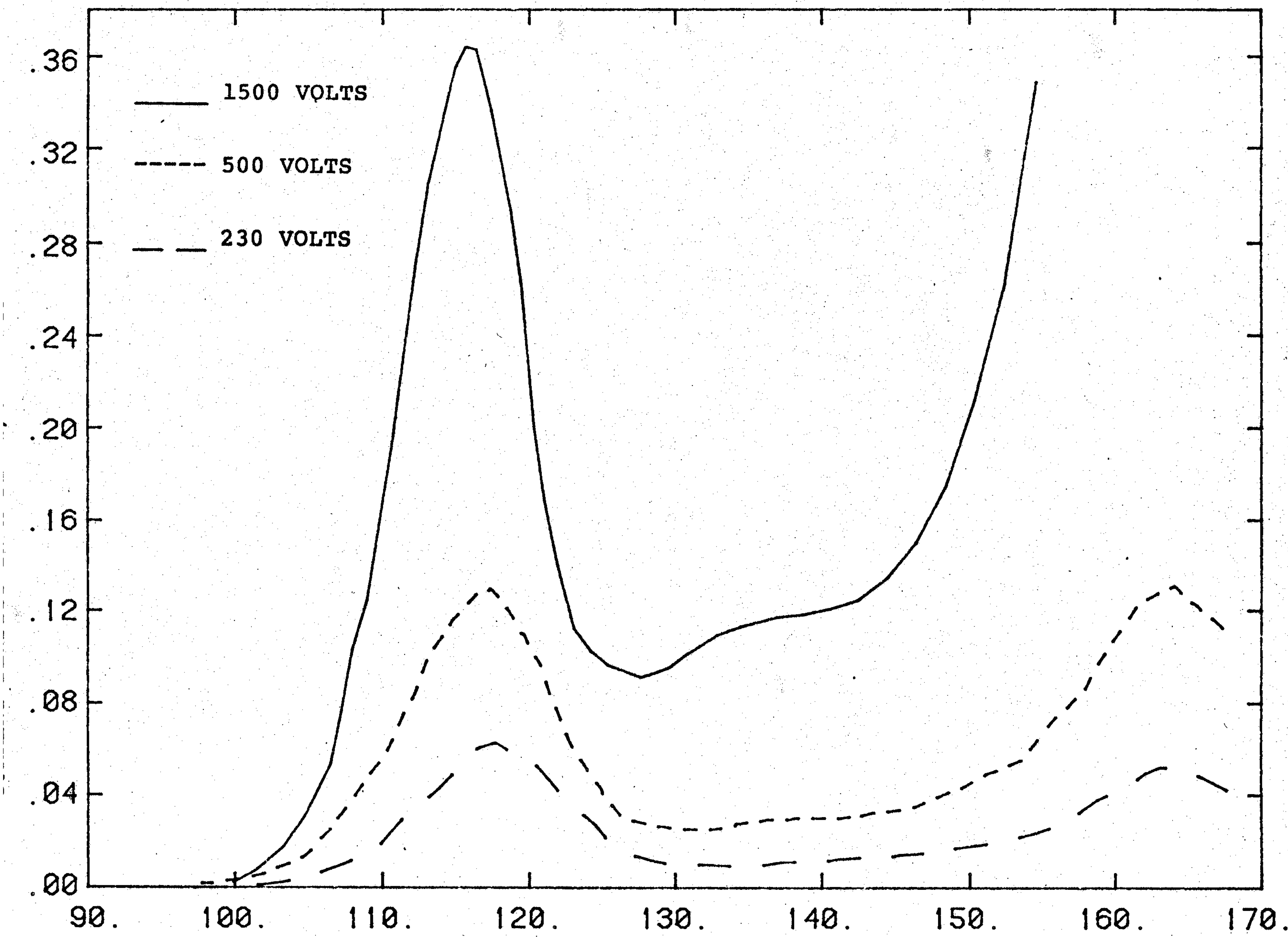
APPENDIX II-CHARGING VOLTAGE TESTS

THIS APPENDIX CONTAINS TSD PLOTS THAT COMPARE SAMPLES CHARGED WITH DIFFERENT CHARGING VOLTAGES.

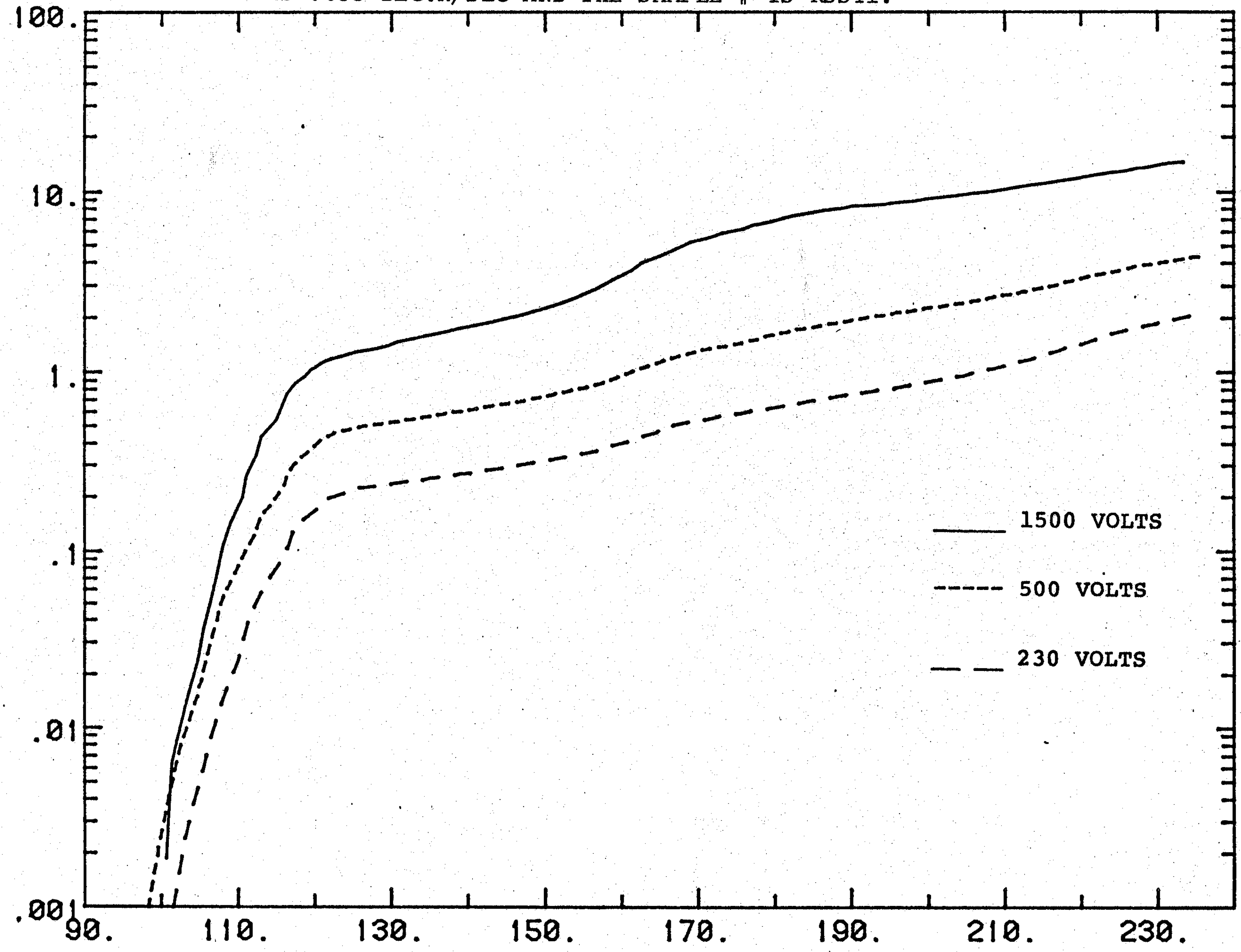
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .033 DEG.K/SEC AND THE SAMPLE # IS RSST1.



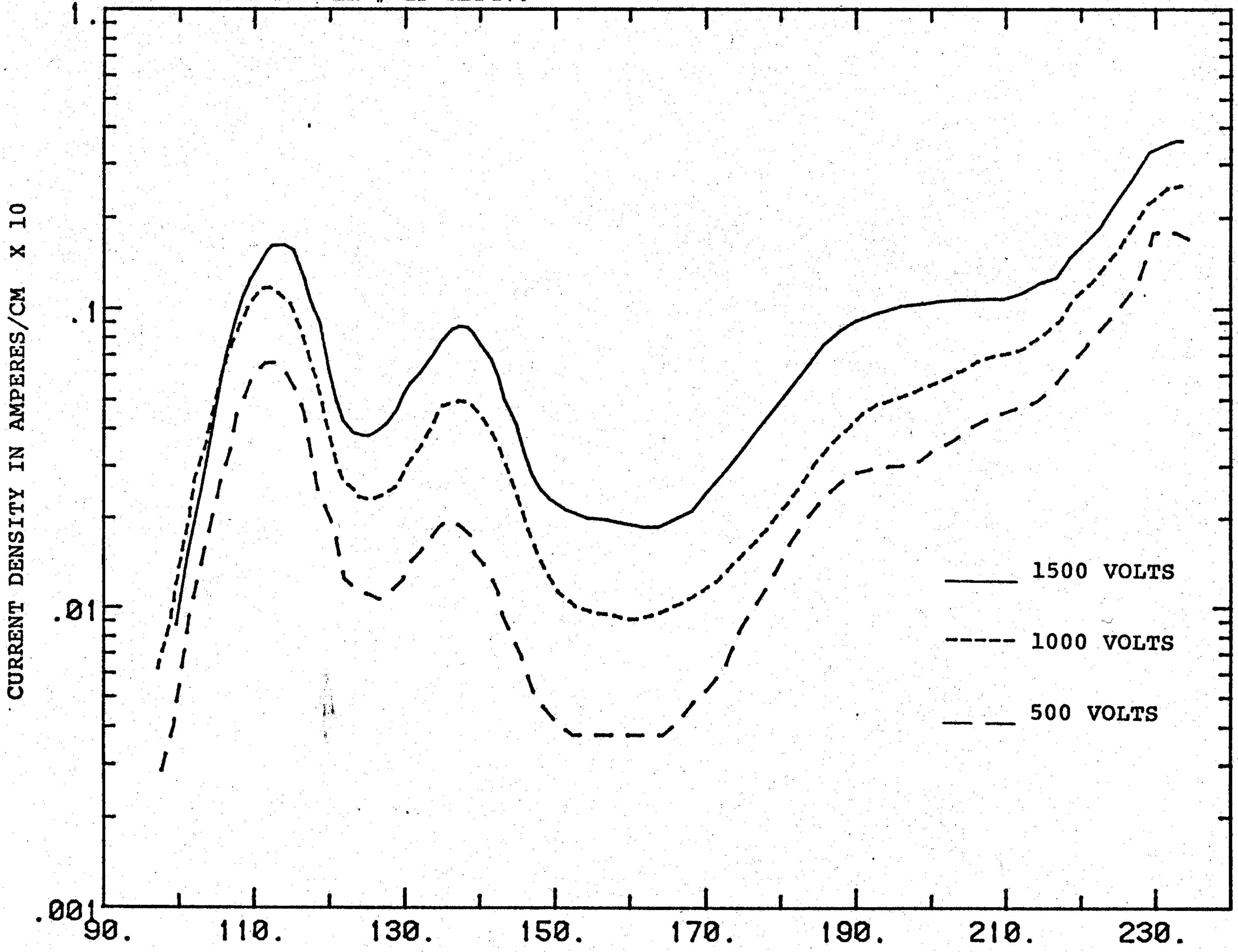
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .033 DEG.K/ SEC AND THE SAMPLE # IS RSST1.



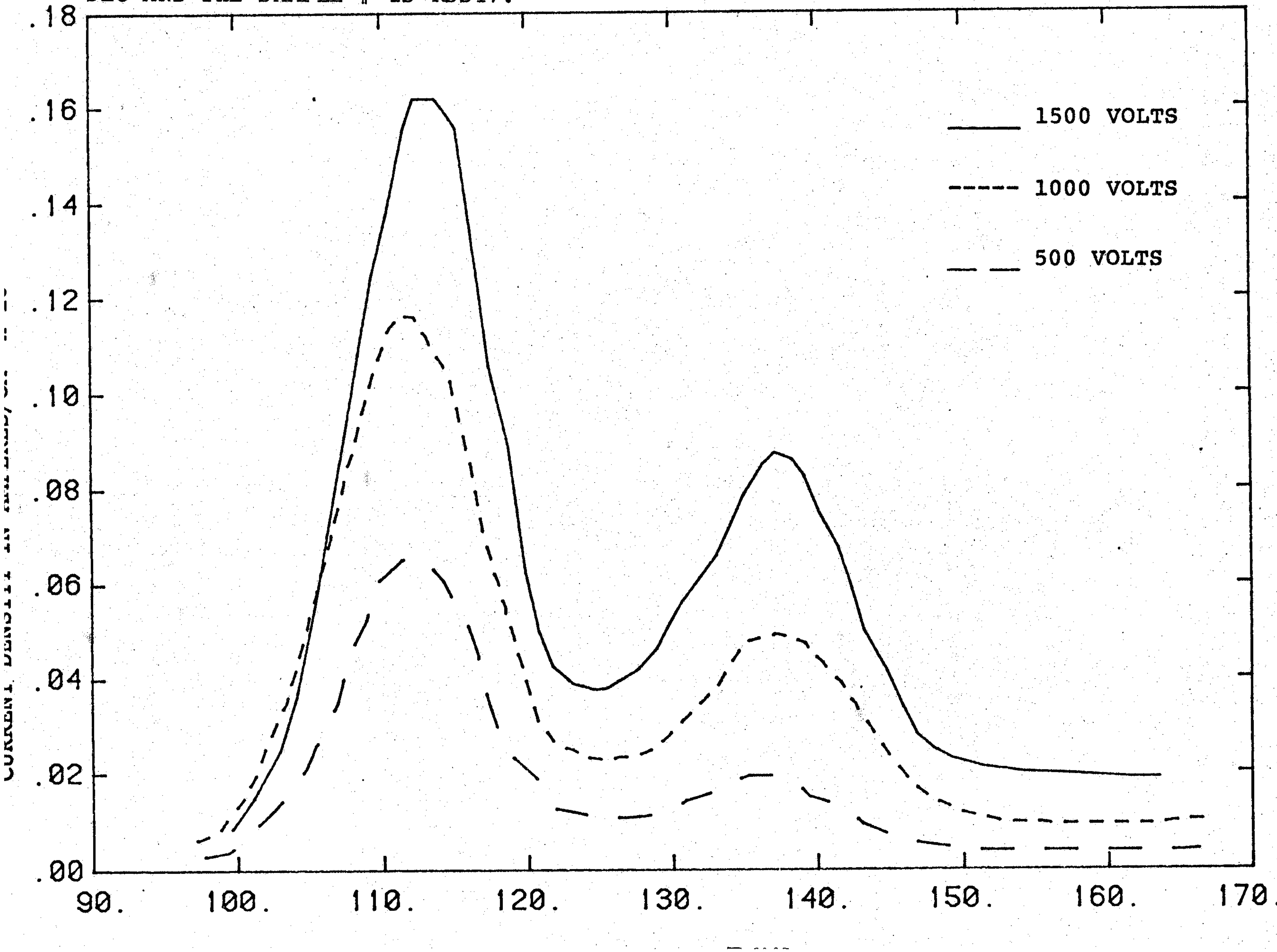
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RESEASED, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .033 DEG.K/SEC AND THE SAMPLE # IS RSST1.



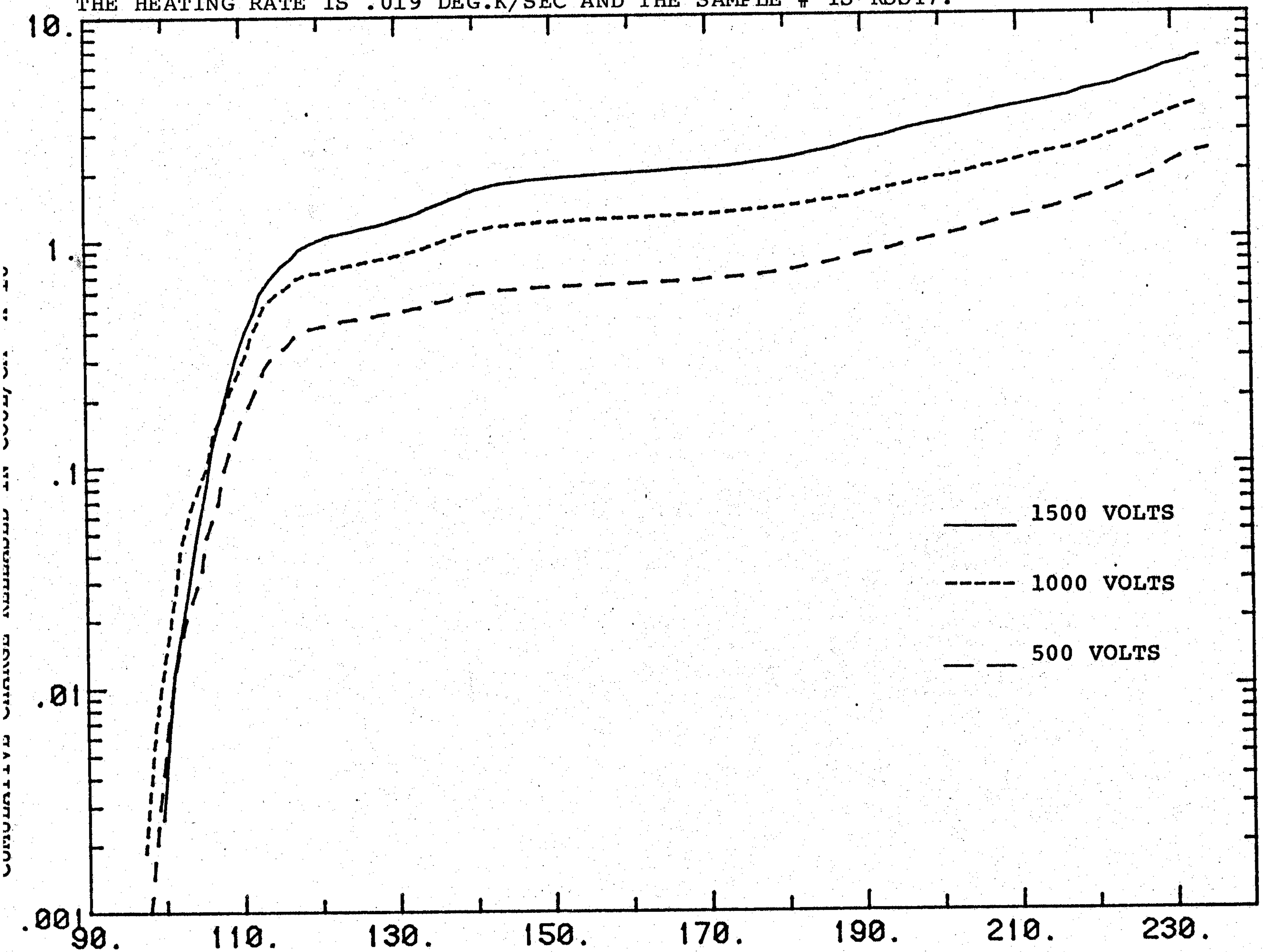
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/ SEC AND THE SAMPLE # IS RSST7.



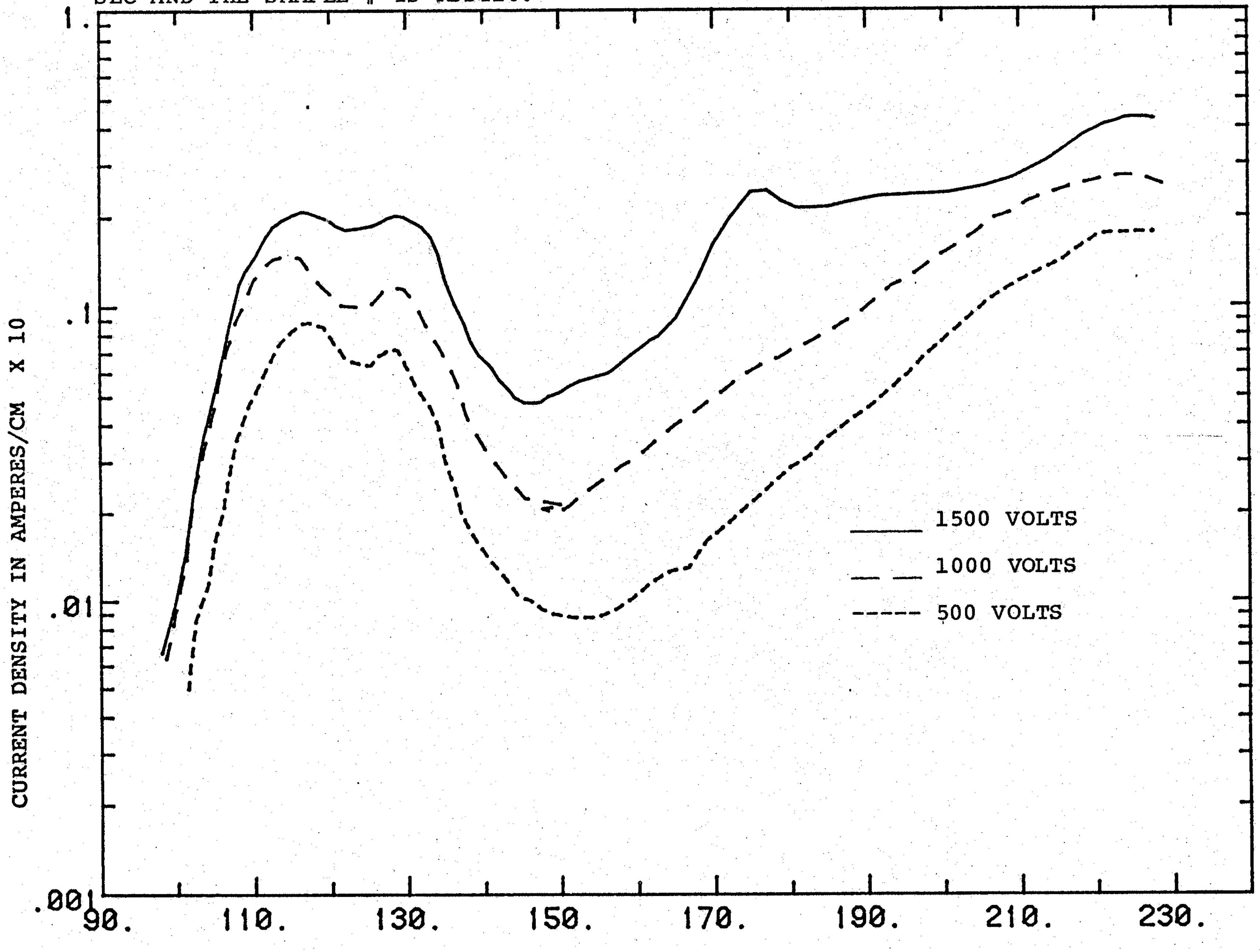
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE SAMPLE # IS RSST7.



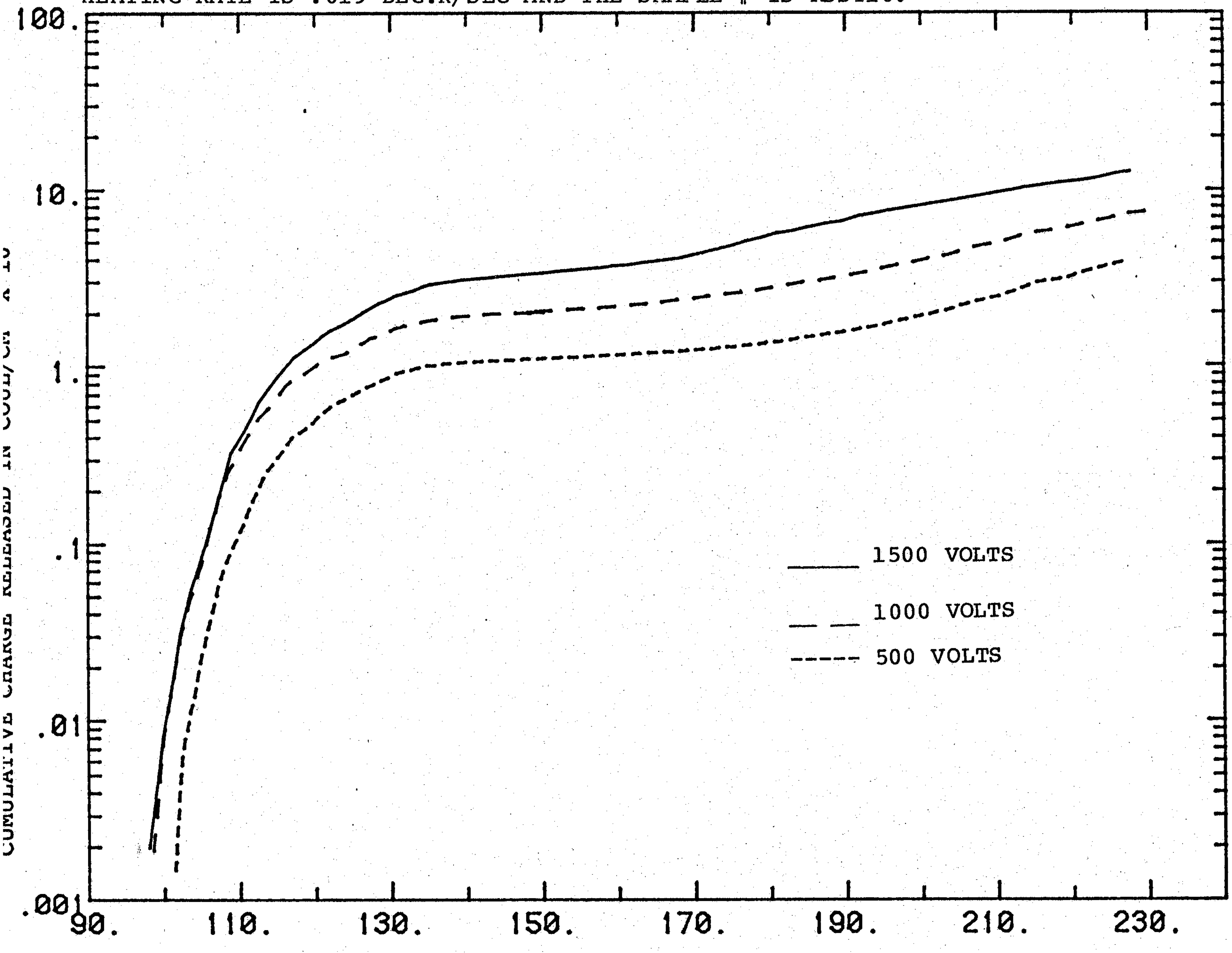
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE SAMPLE # IS RSST7.



SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE SAMPLE # IS RSST10.



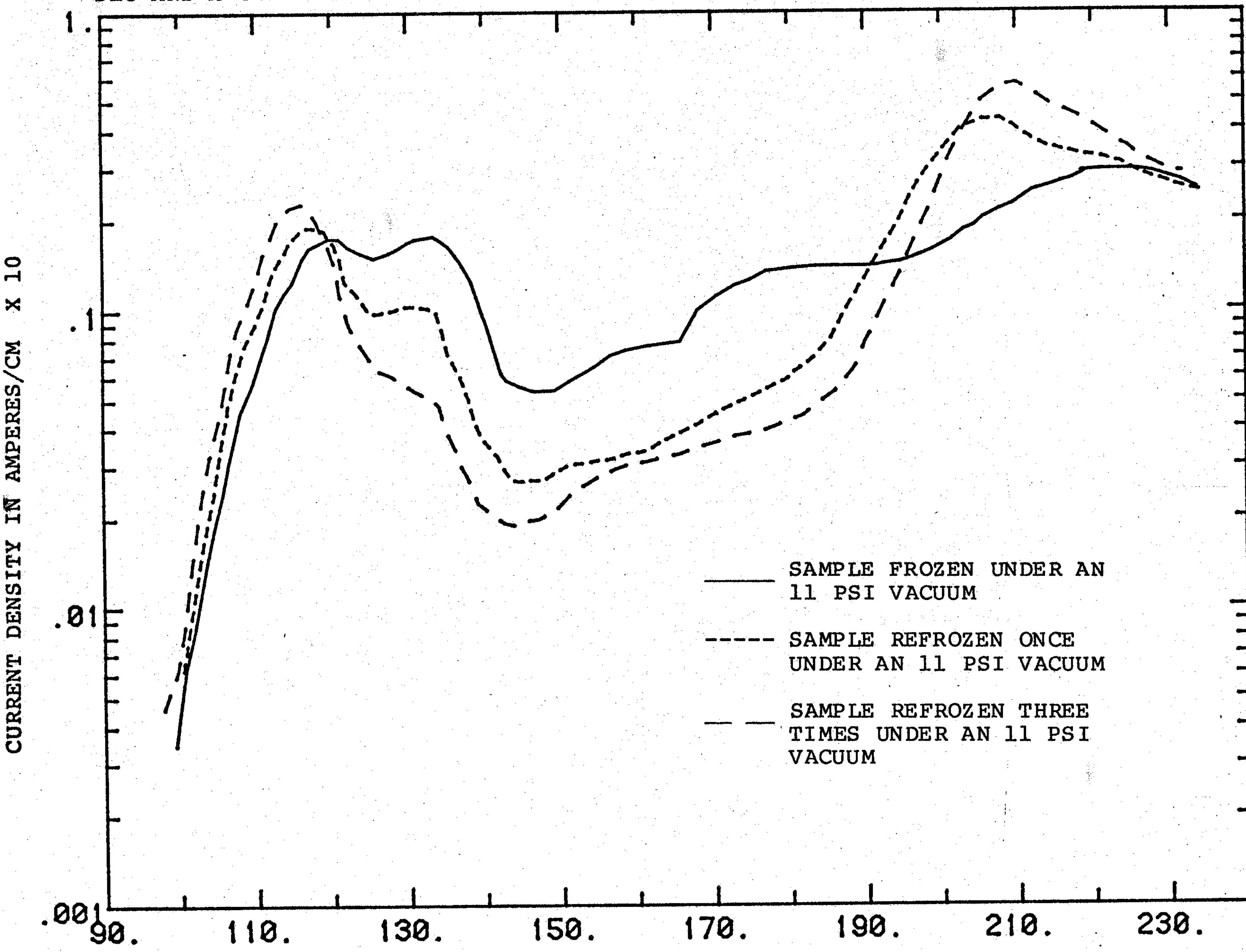
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE, WITH DIFFERENT CHARGING VOLTAGES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE HEATING RATE IS .019 DEG.K/SEC AND THE SAMPLE # IS RSST10.



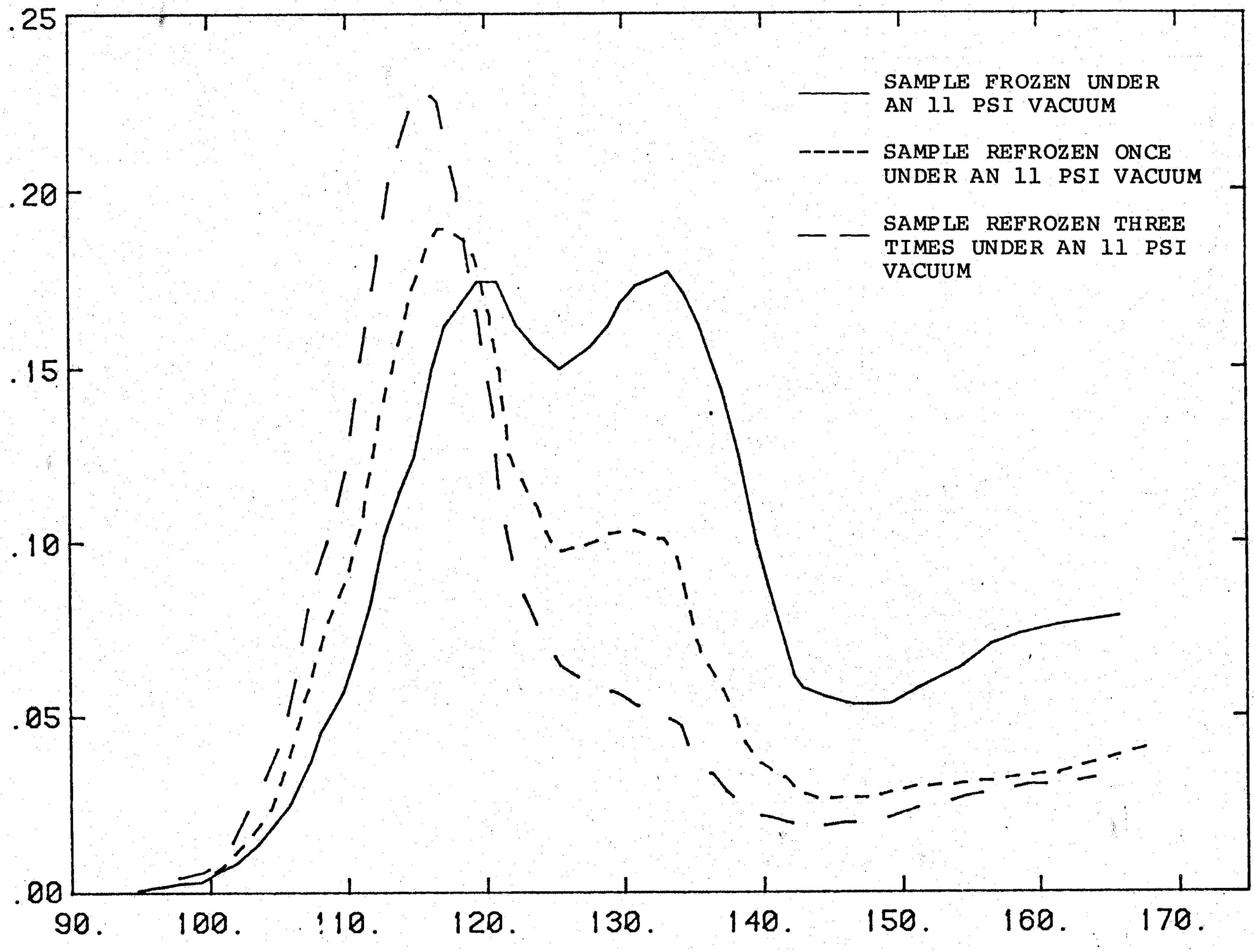
APPENDIX III-REFREEZING TESTS

THIS APPENDIX CONTAINS TSD PLOTS THAT COMPARE SAMPLES THAT HAVE BEEN FROZEN UNDER AN 11 PSI VACUUM, REFROZEN UNDER AN 11 PSI VACUUM, AND REFROZEN UNDER CARBON DIOXIDE.

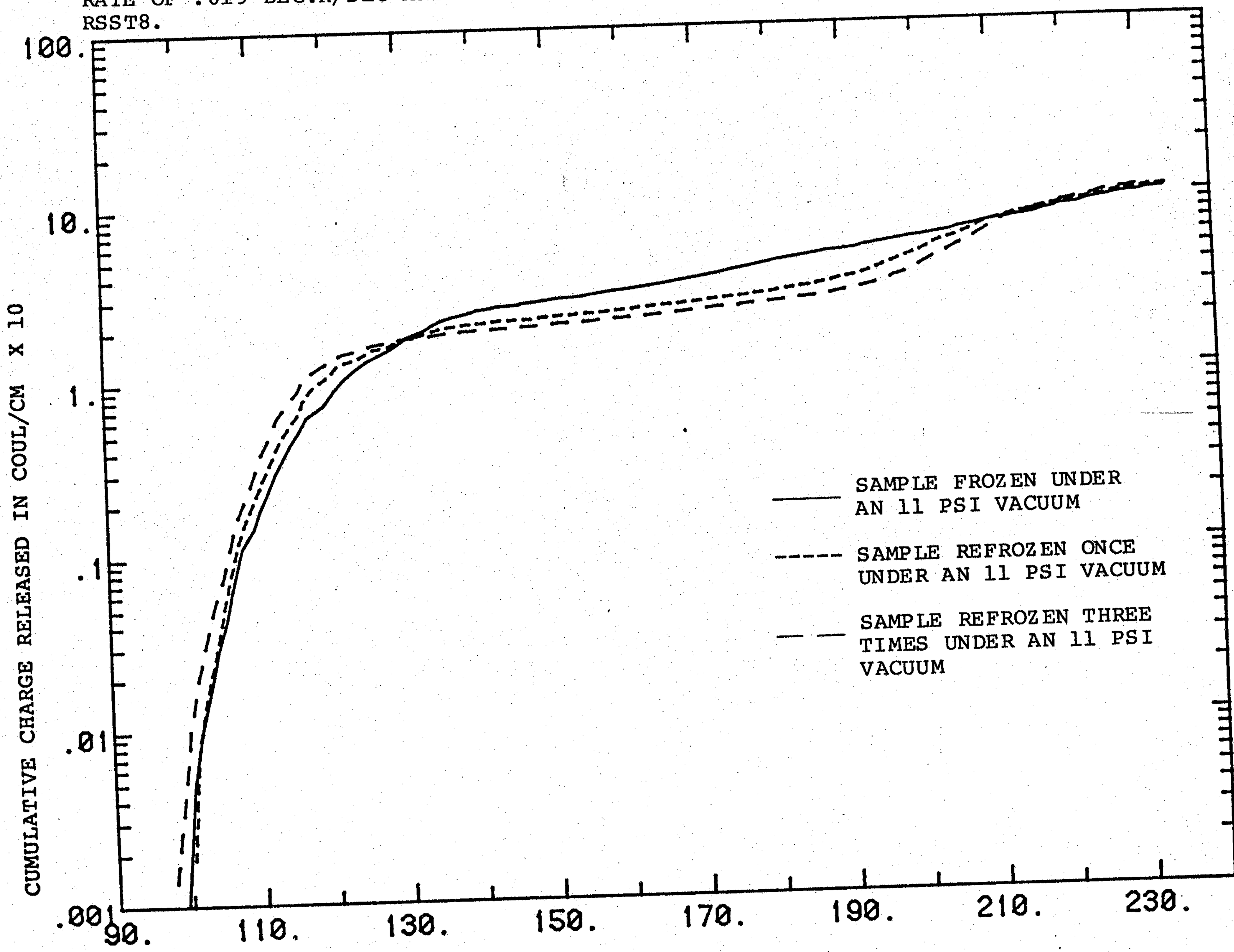
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/ SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST8.



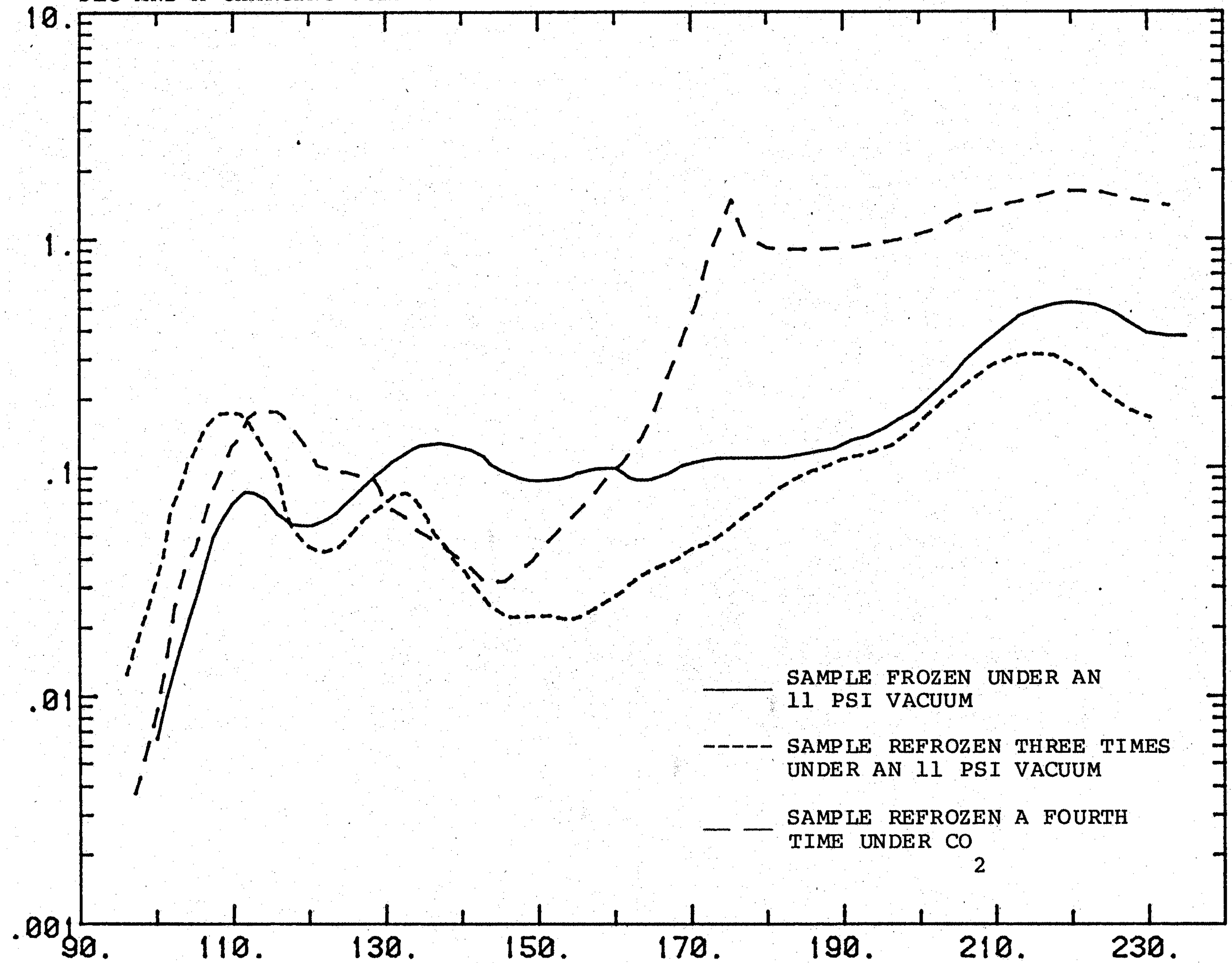
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST8.



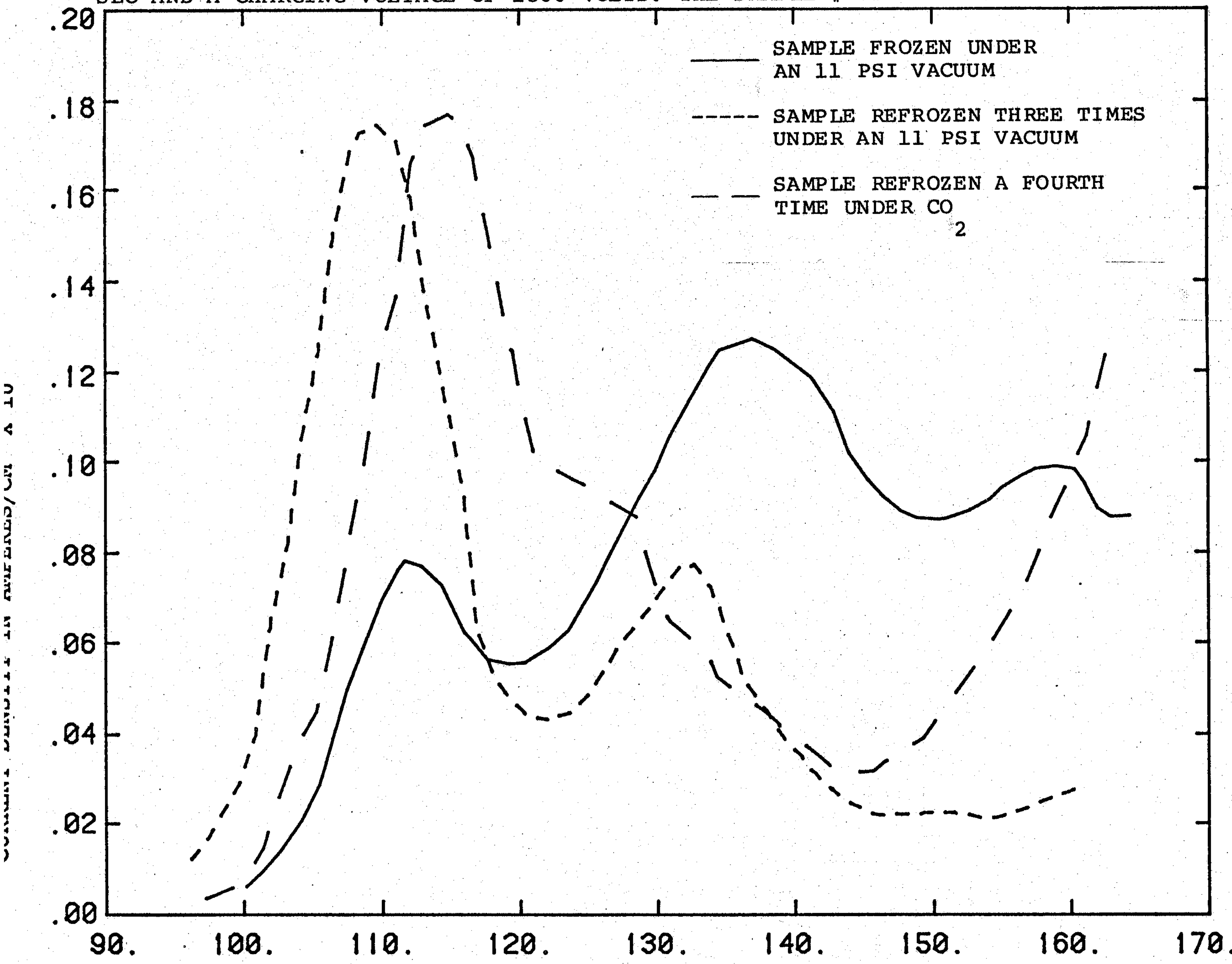
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST8.



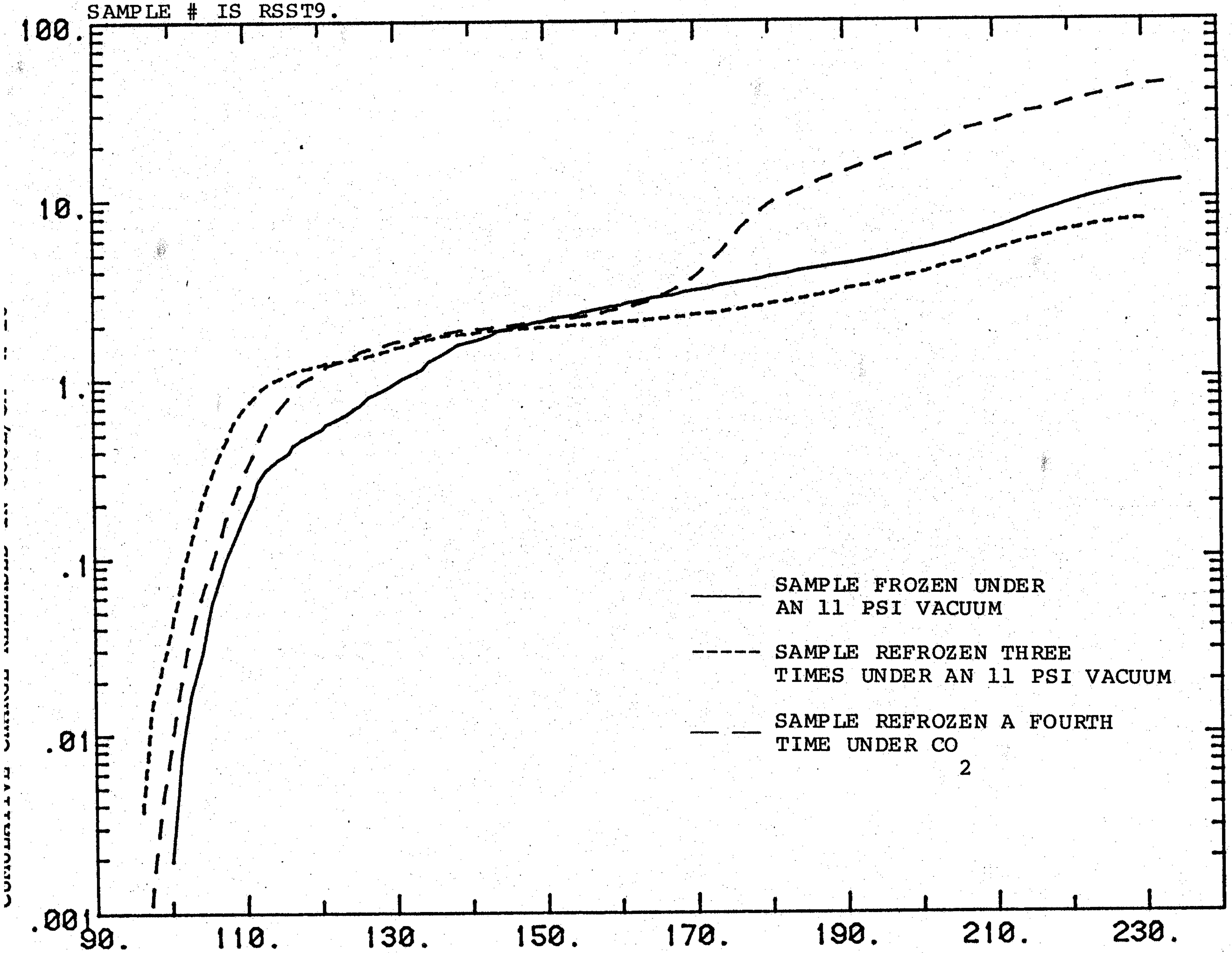
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST9.



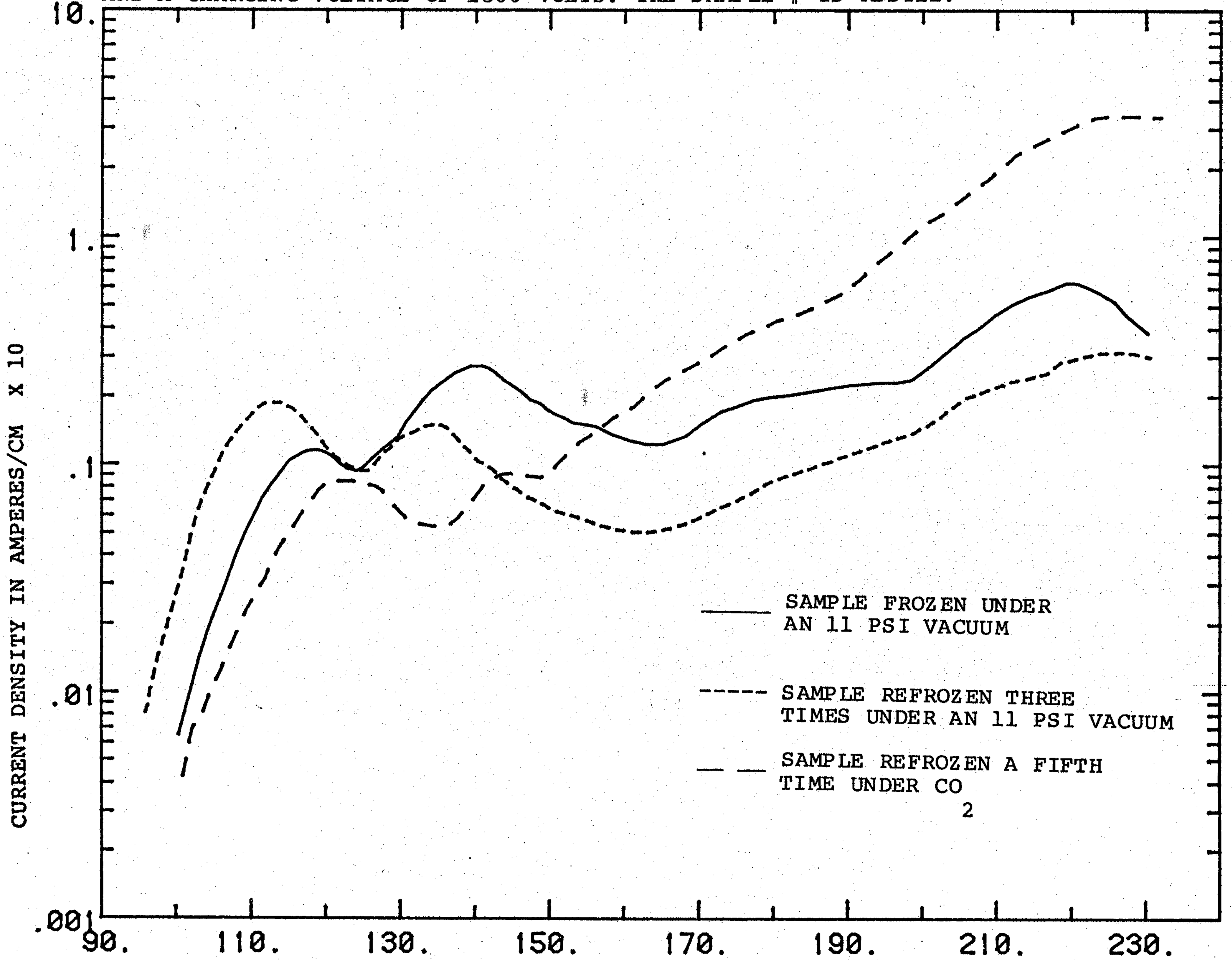
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST9.



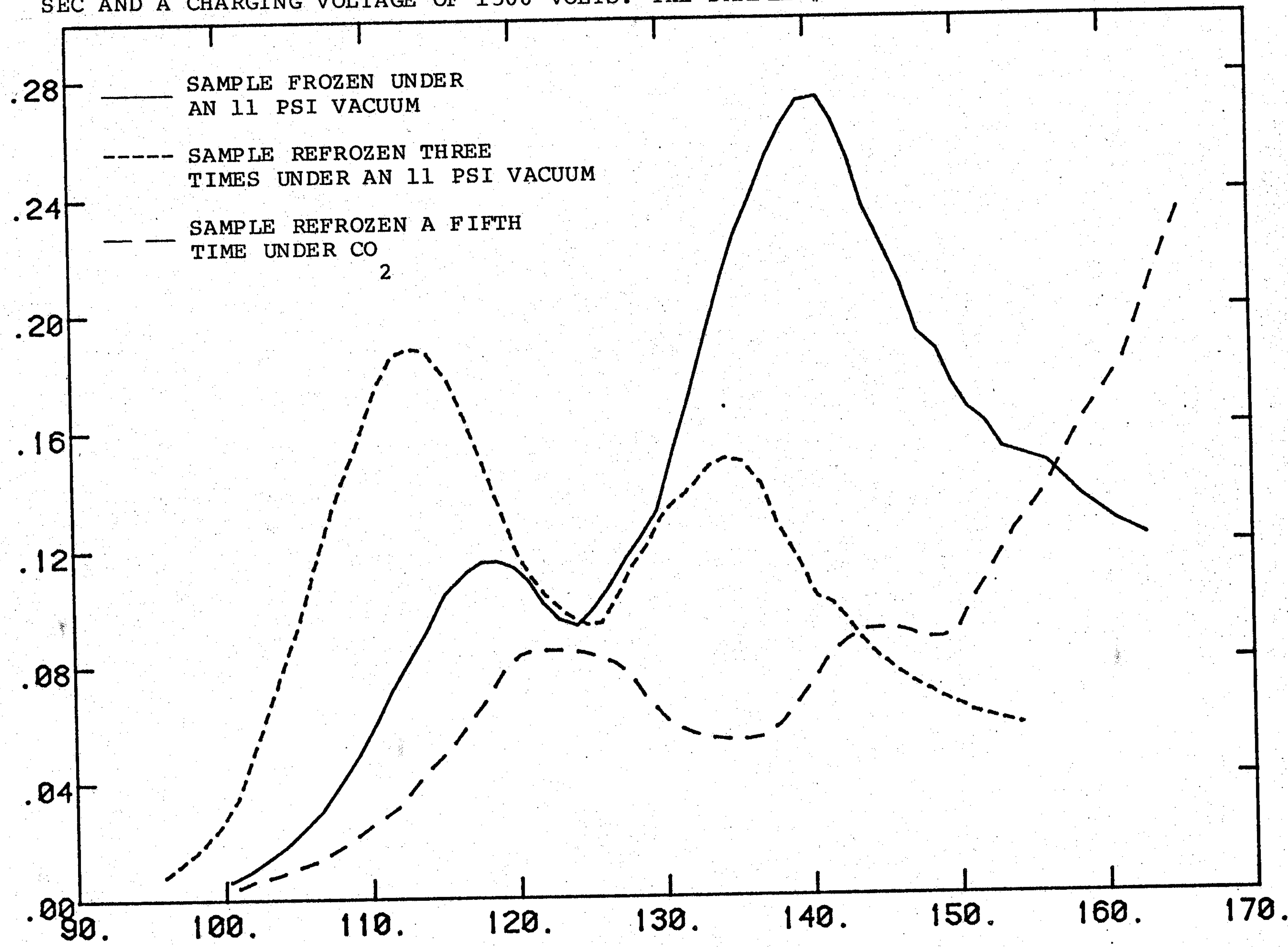
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST9.



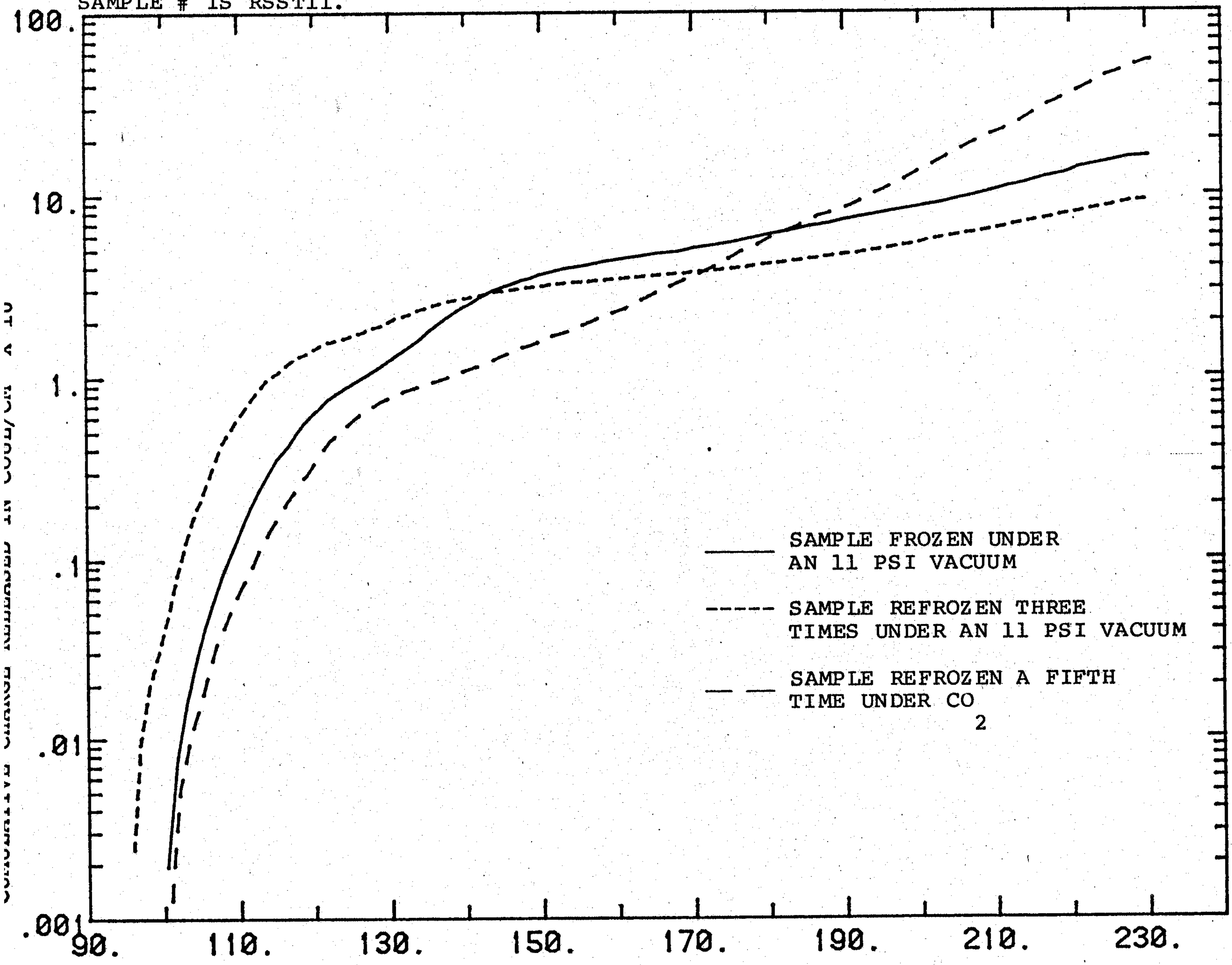
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST11.



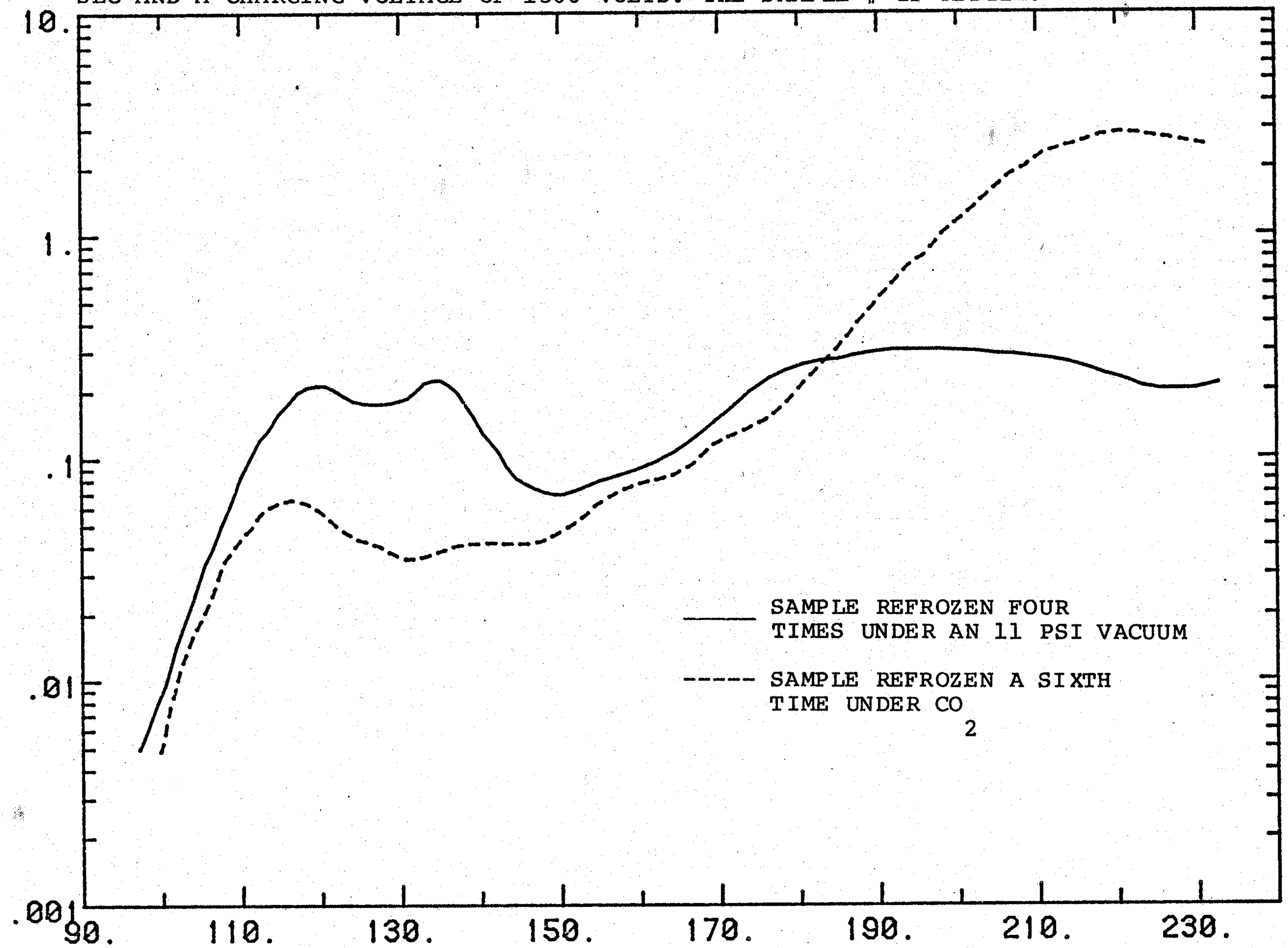
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST11.



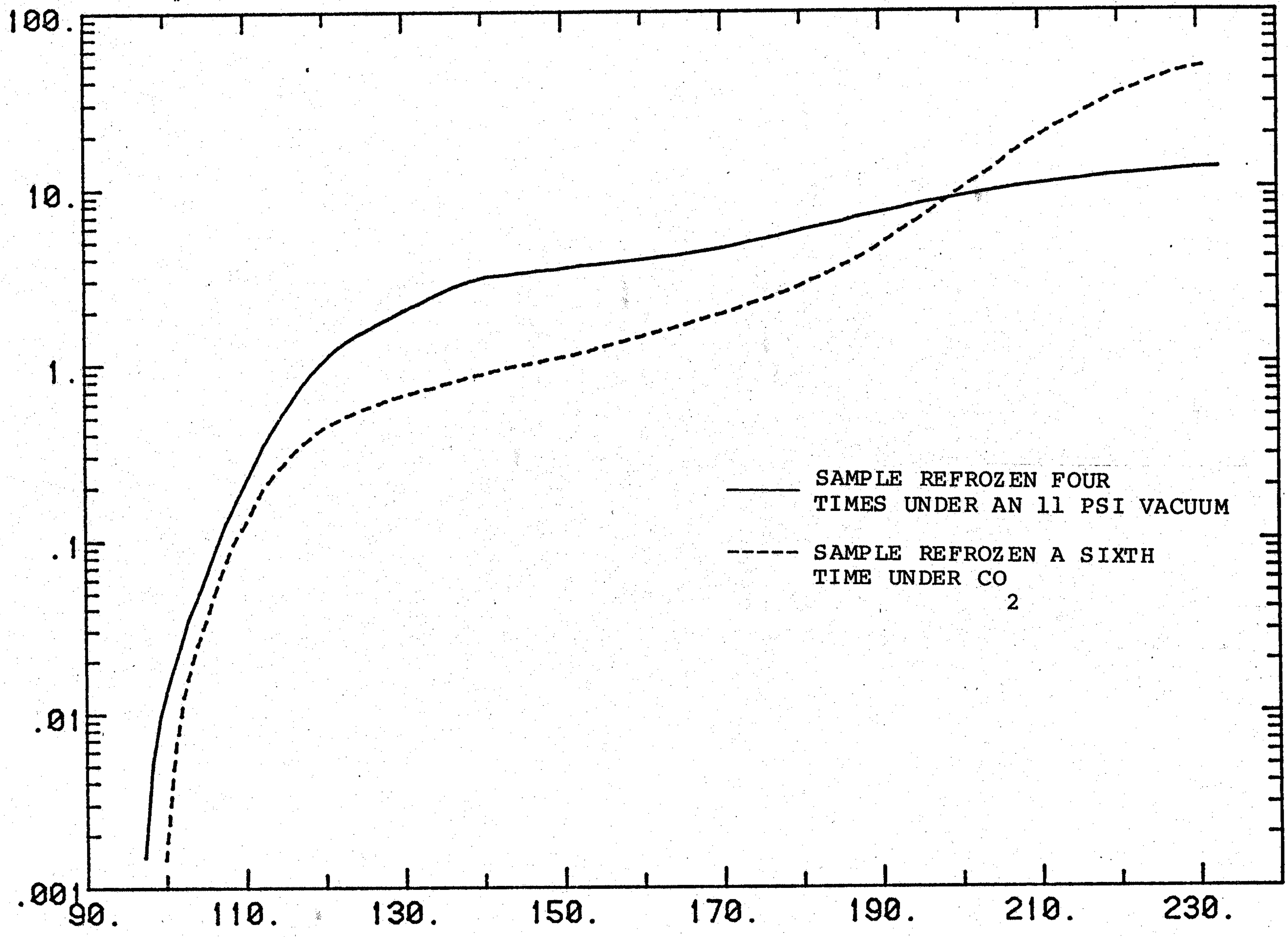
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST11.



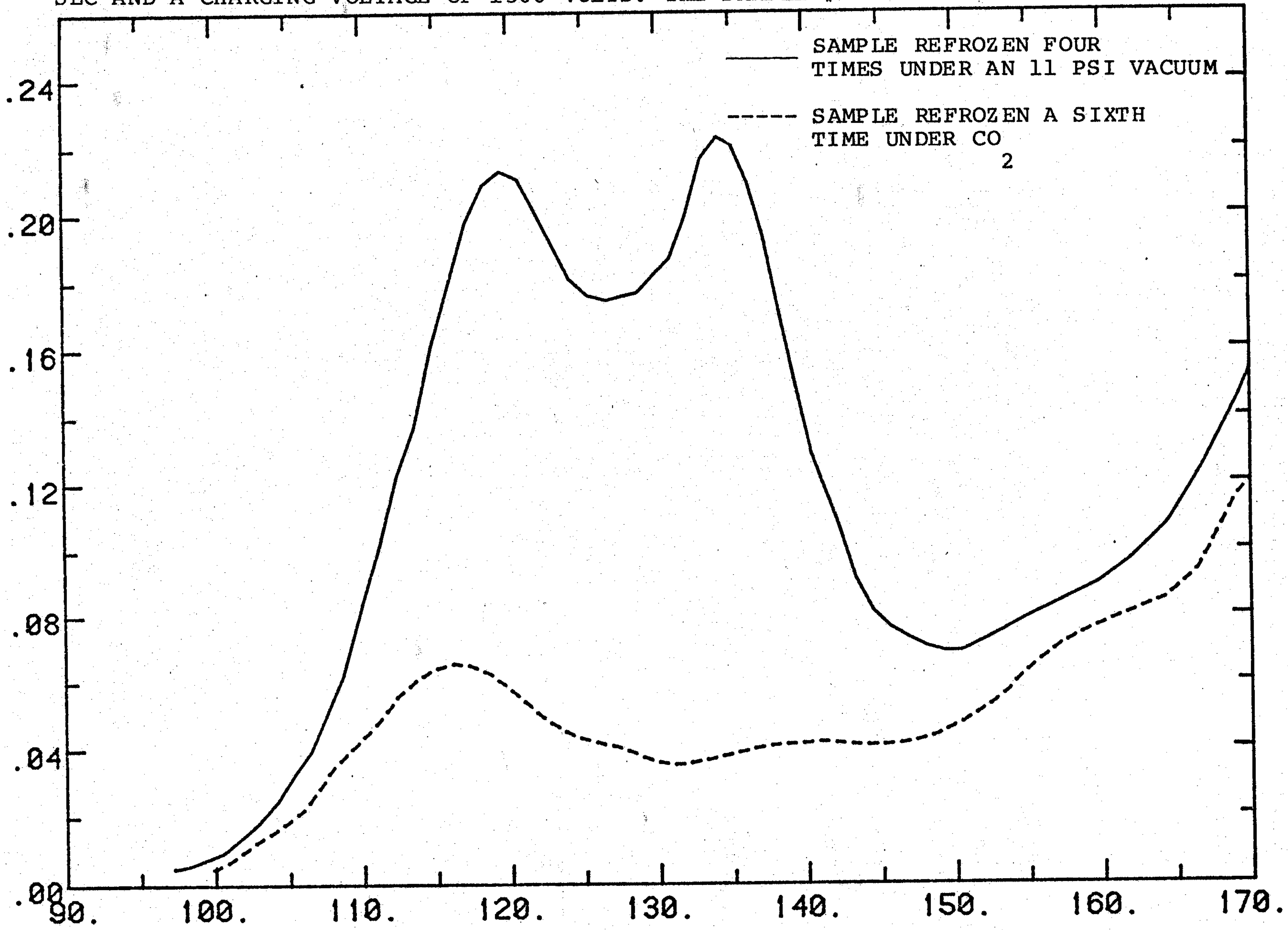
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST12.



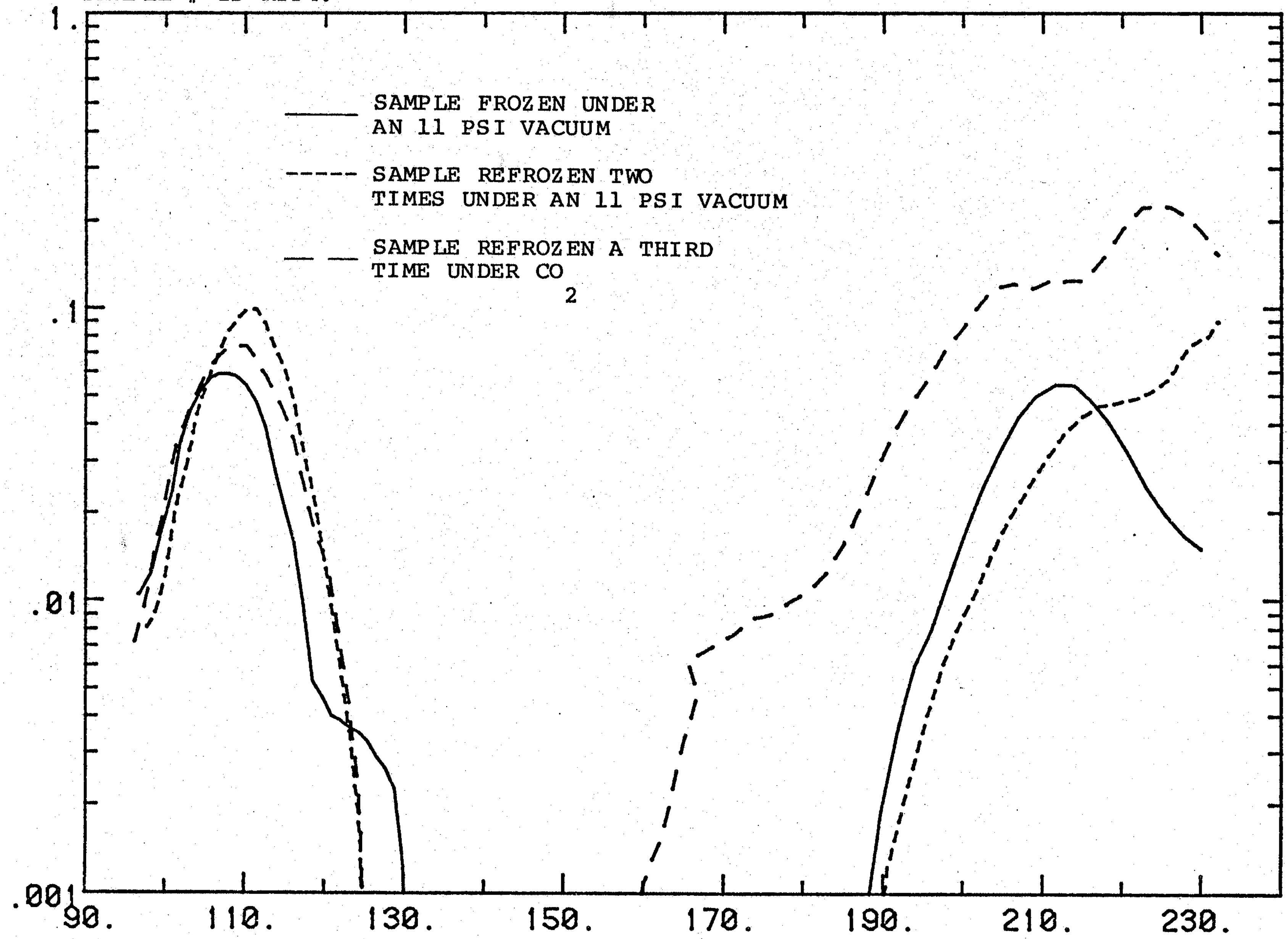
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST12.



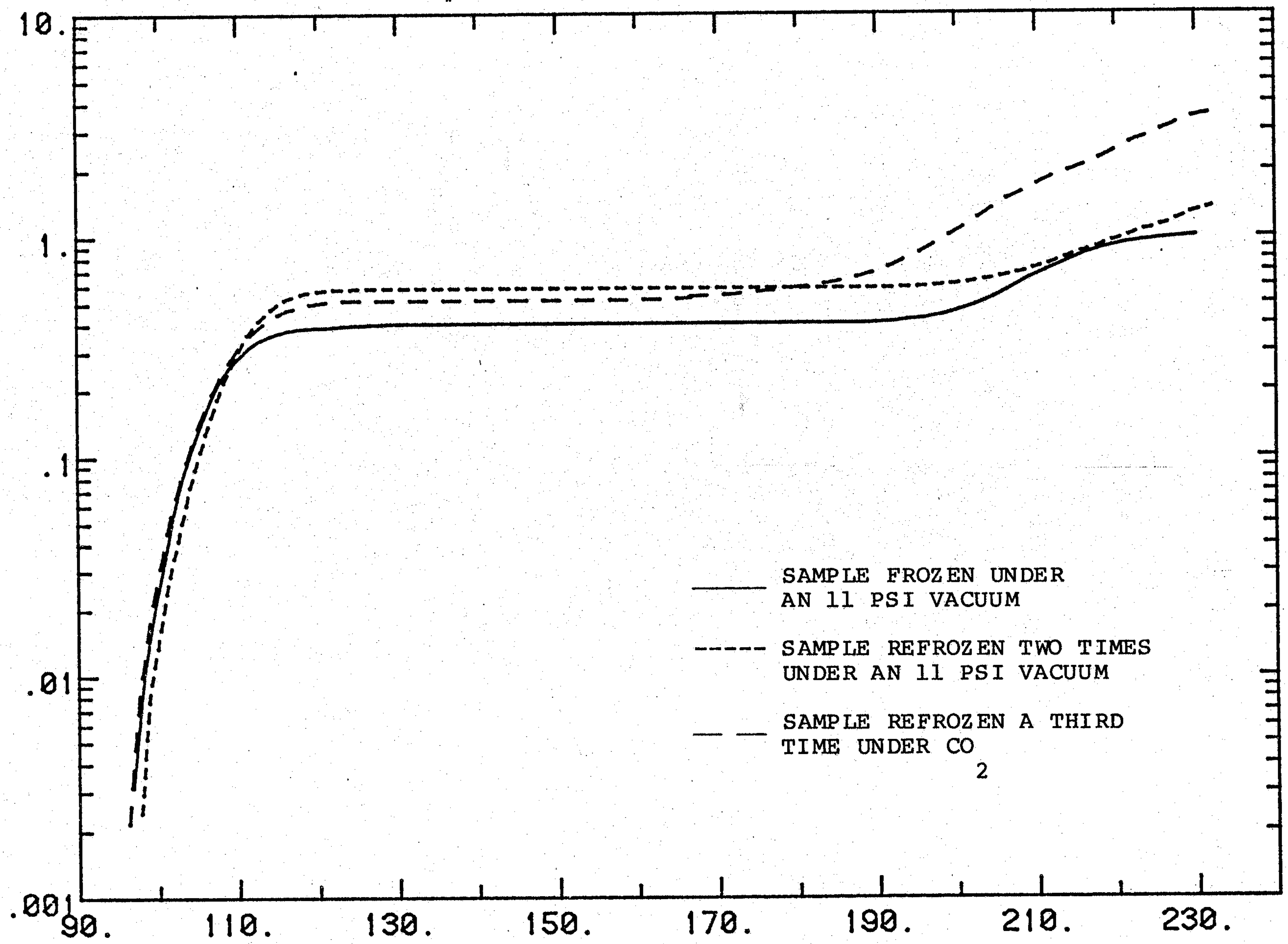
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RSST12.



SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN WITH TEFLON BLOCKING LAYERS. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RTF4.



SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN WITH TEFLON BLOCKING LAYERS. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RTF4.



SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN WITH TEFLON BLOCKING LAYERS. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF 0.019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RTF5.

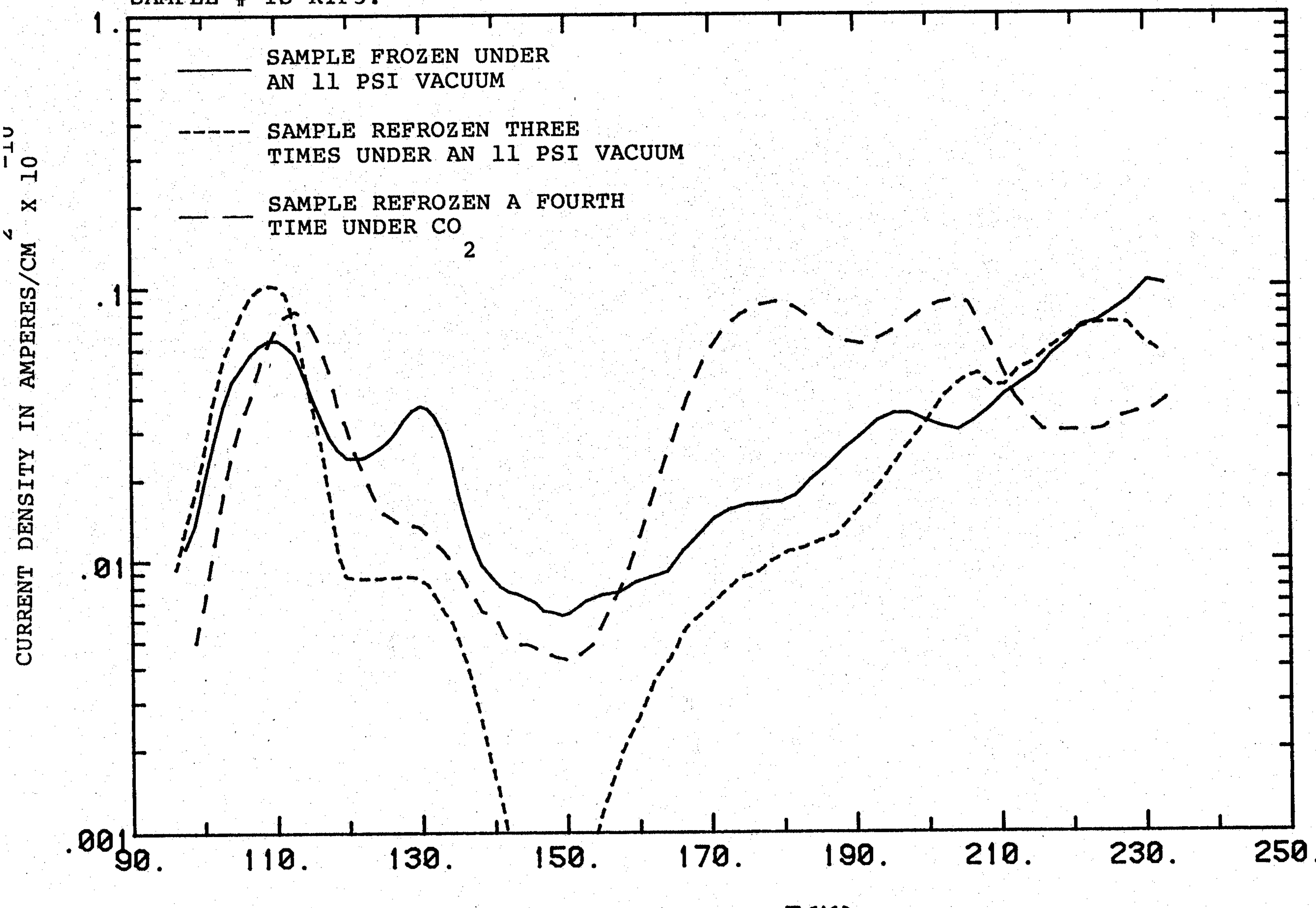


FIG. 48

SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN WITH TEFLON BLOCKING LAYERS. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RTF5.

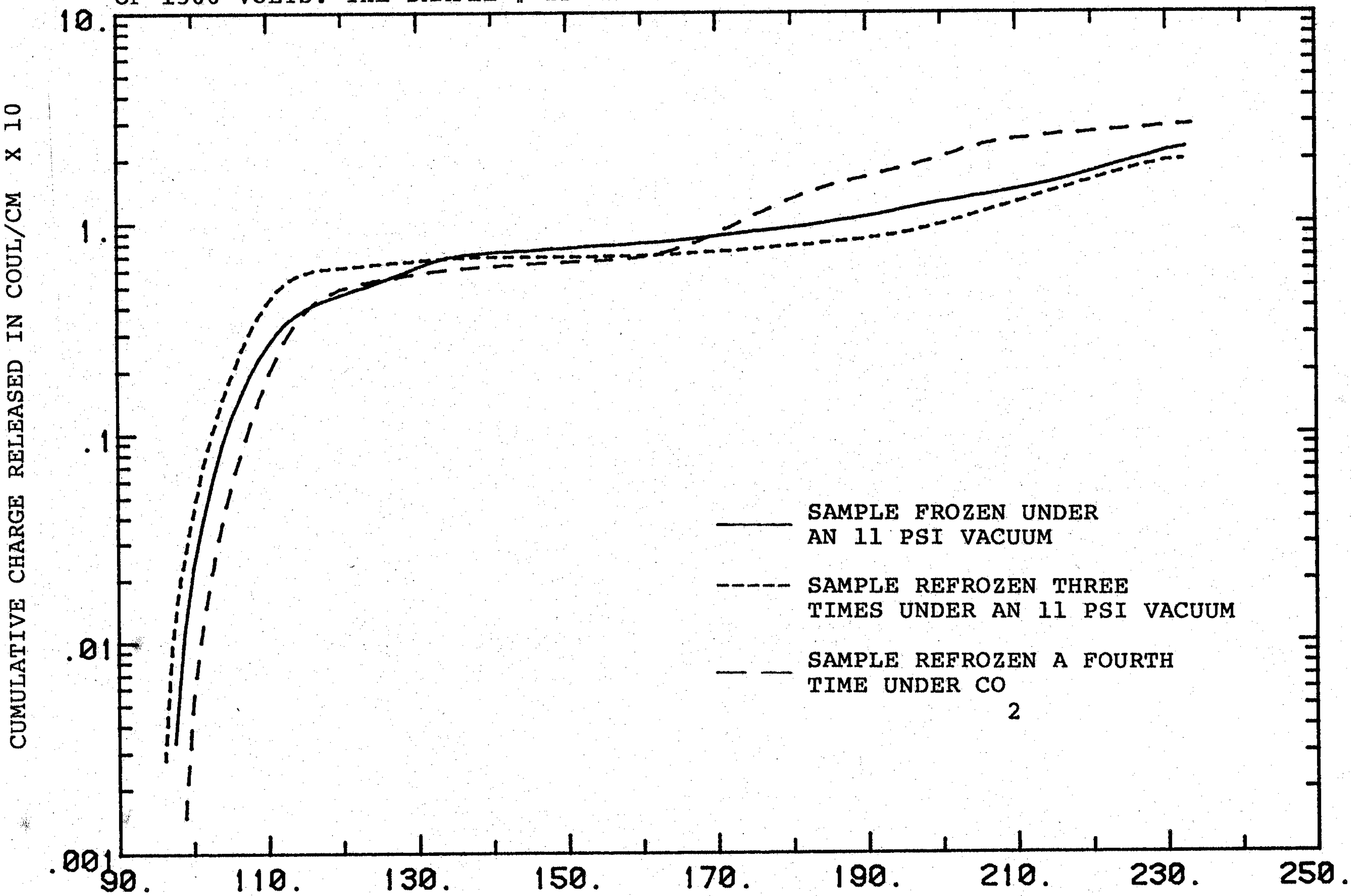


FIG. 49

SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN WITH TEFLON BLOCKING LAYERS. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RTF6.

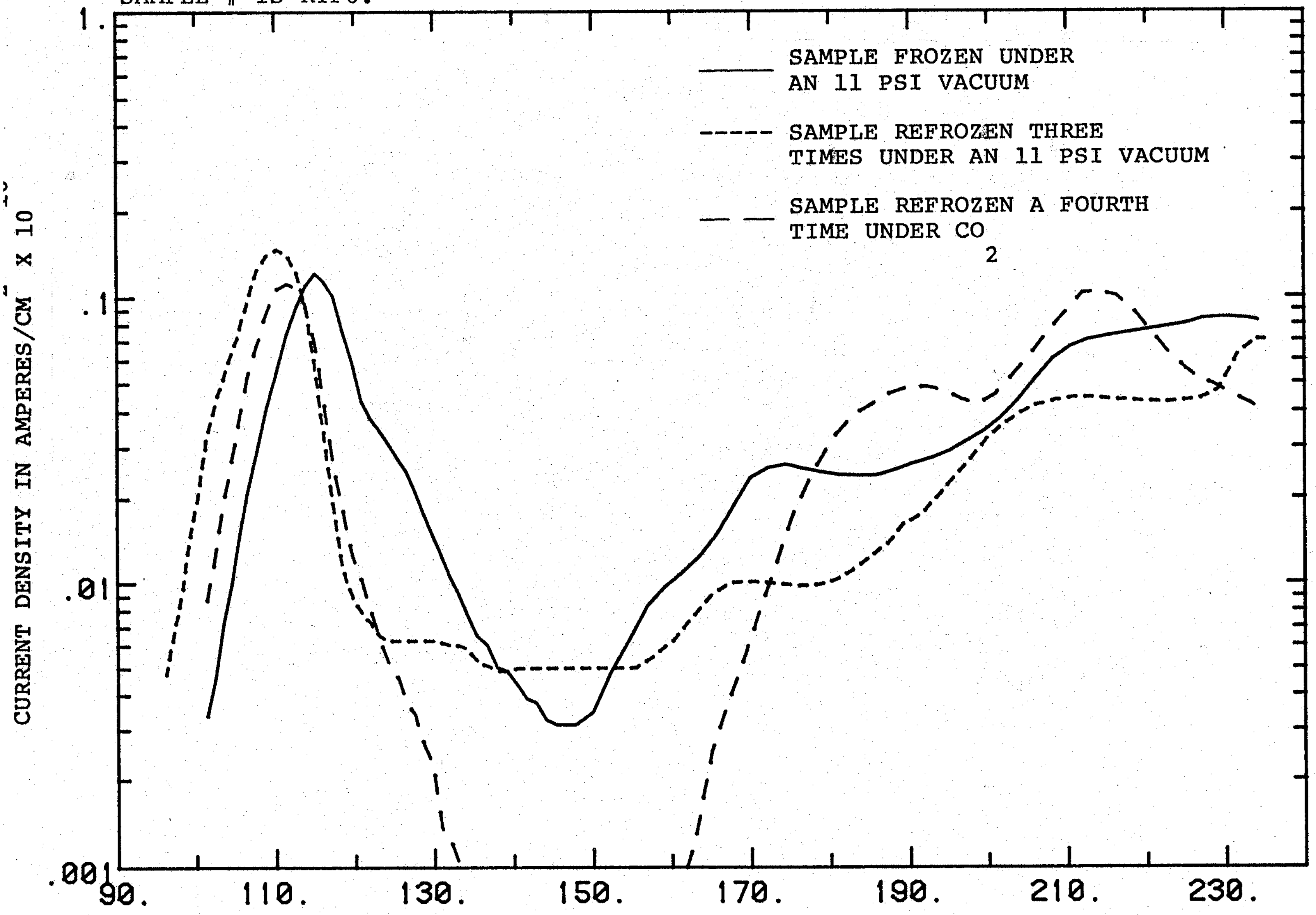


FIG. 50

SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE THAT HAS BEEN REFROZEN WITH TEFLON BLOCKING LAYERS. THE CONCENTRIC-CYLINDER SAMPLE HOLDER IS USED WITH A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS. THE SAMPLE # IS RTF6.

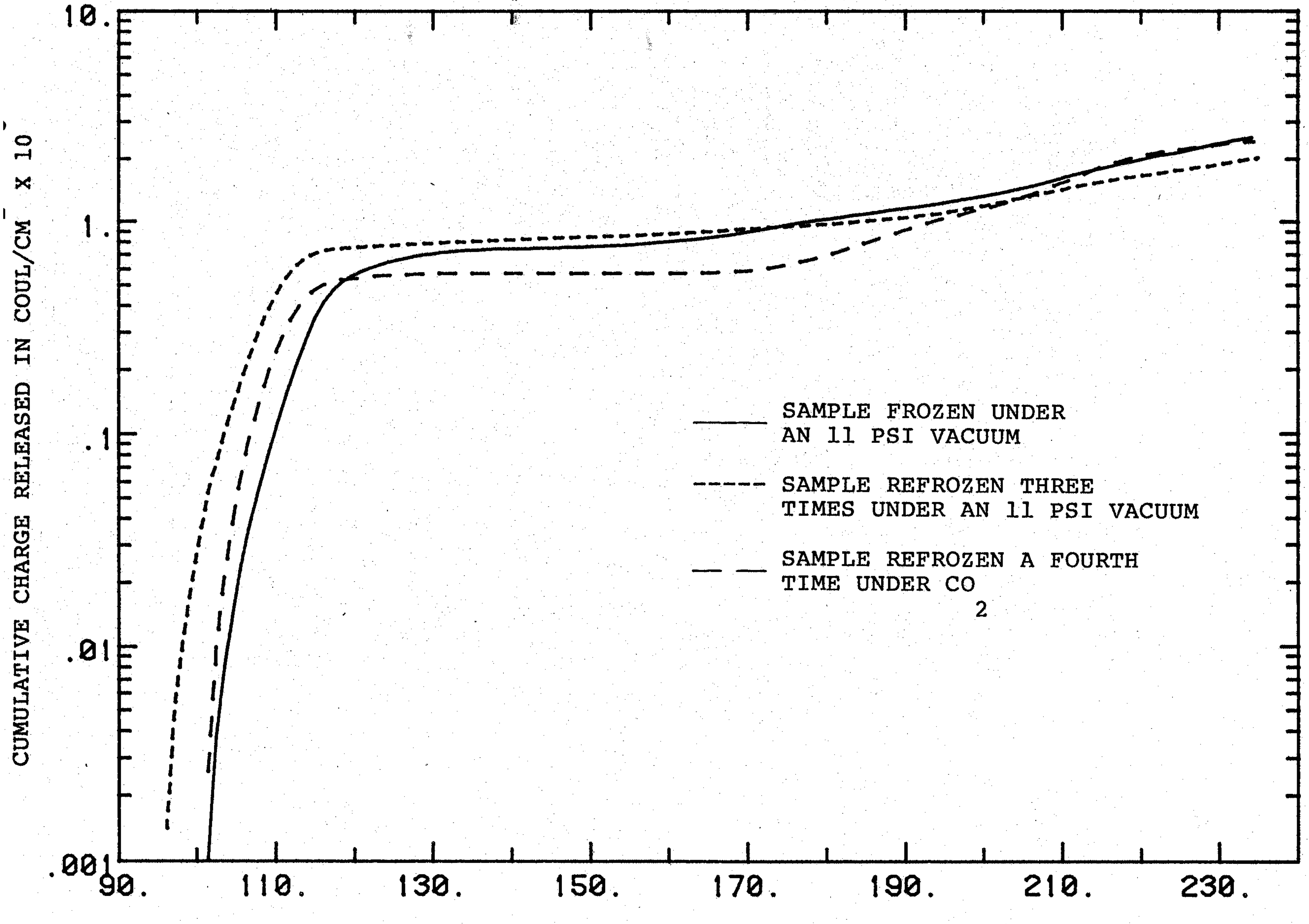
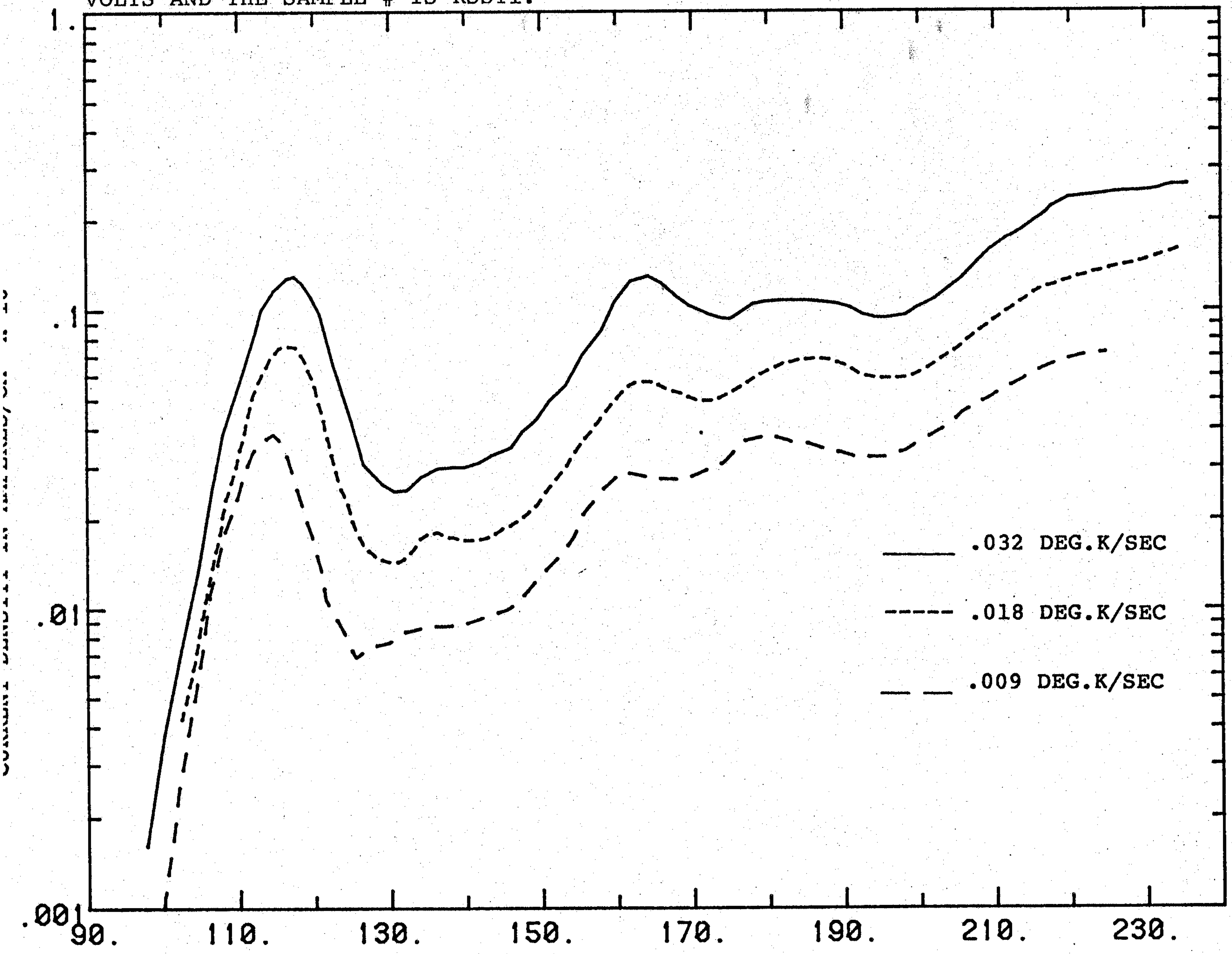


FIG. 51

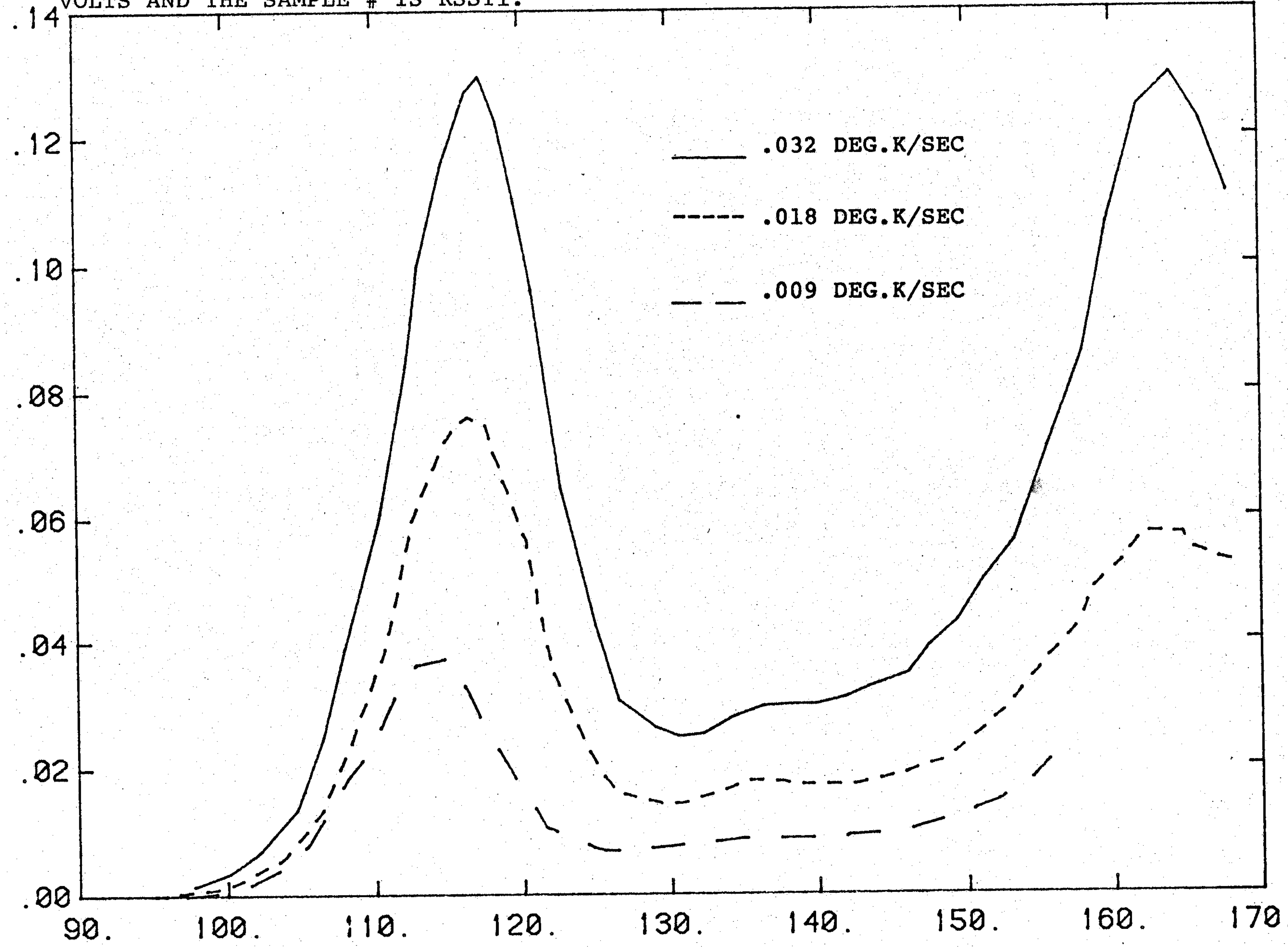
APPENDIX IV-HEATING RATE TESTS

THIS APPENDIX CONTAINS TSD PLOTS THAT COMPARE SAMPLES RUN AT DIFFERENT HEATING RATES.

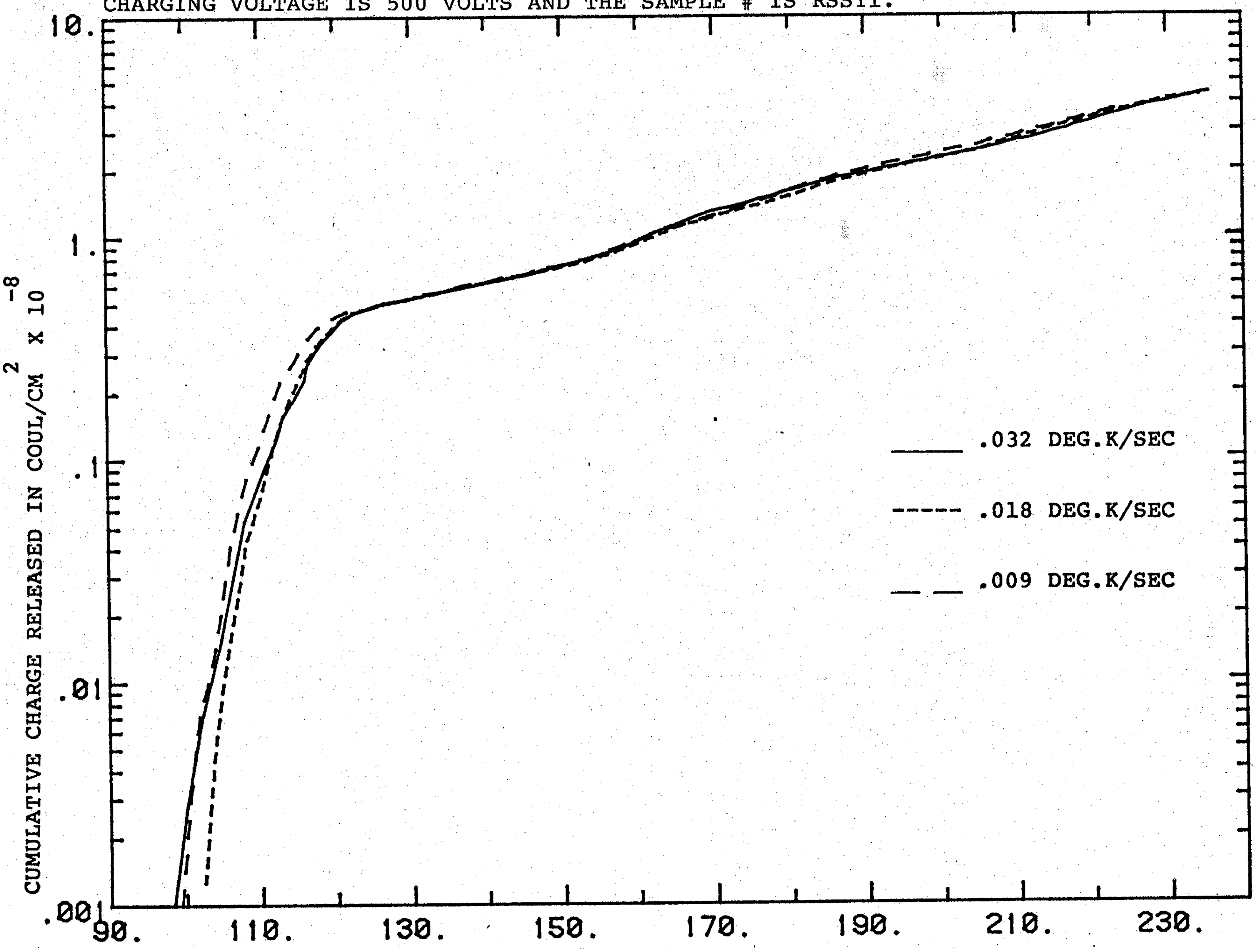
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE, RUN AT DIFFERENT HEATING RATES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE CHARGING VOLTAGE IS 500 VOLTS AND THE SAMPLE # IS RSST1.



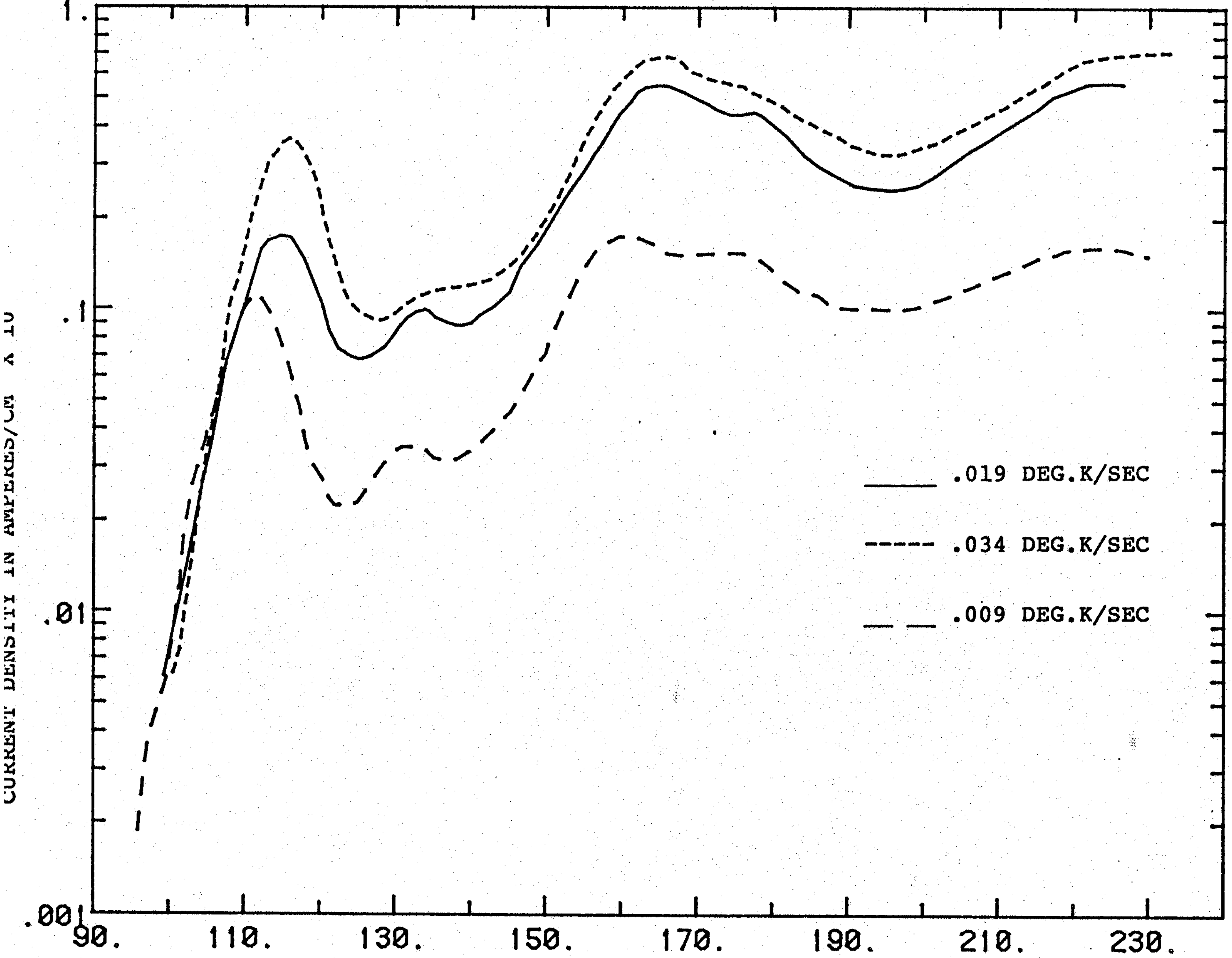
LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE, RUN AT DIFFERENT HEATING RATES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE CHARGING VOLTAGE IS 500 VOLTS AND THE SAMPLE # IS RSST1.



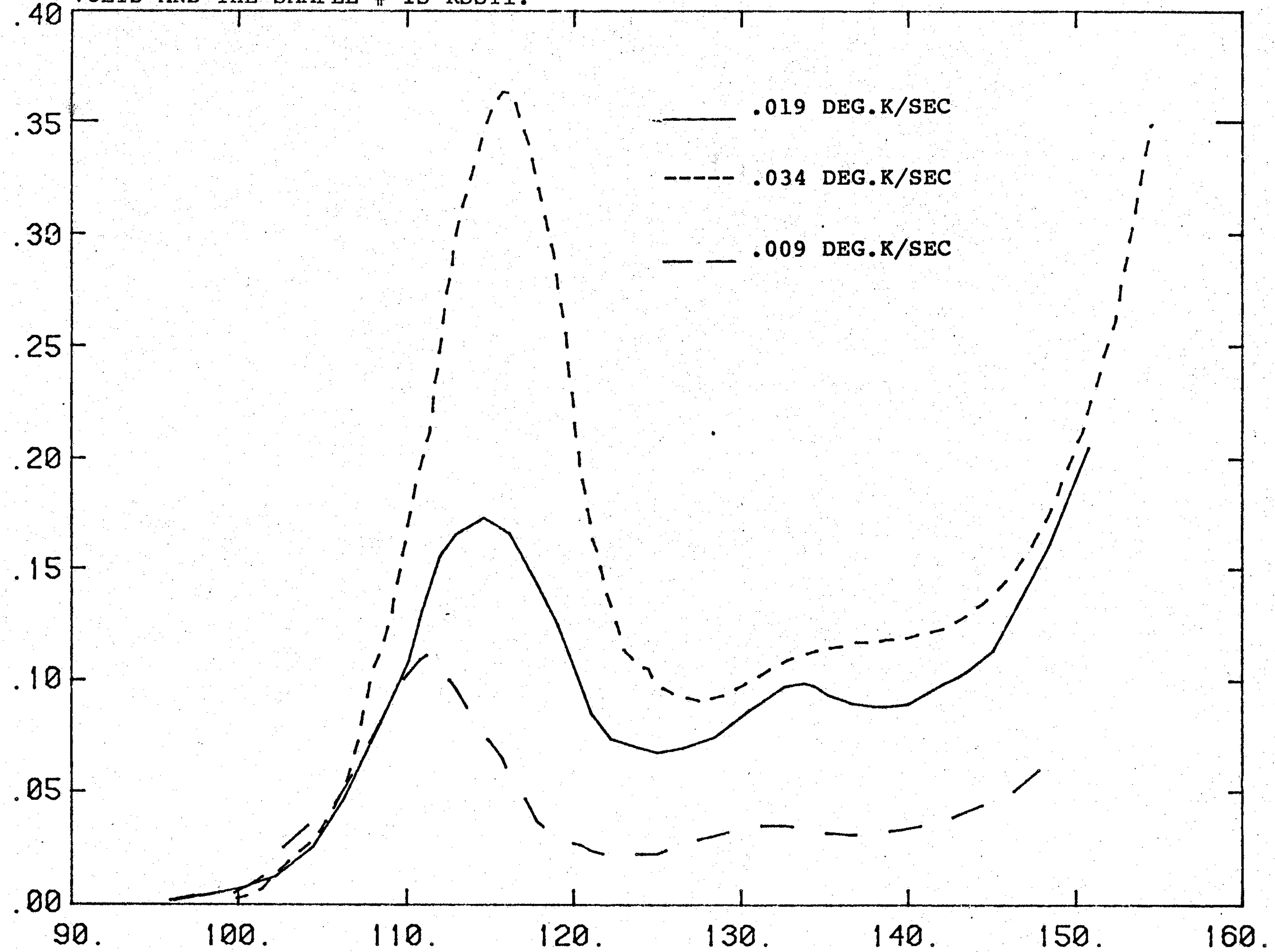
SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE RUN AT DIFFERENT HEATING RATES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE CHARGING VOLTAGE IS 500 VOLTS AND THE SAMPLE # IS RSST1.



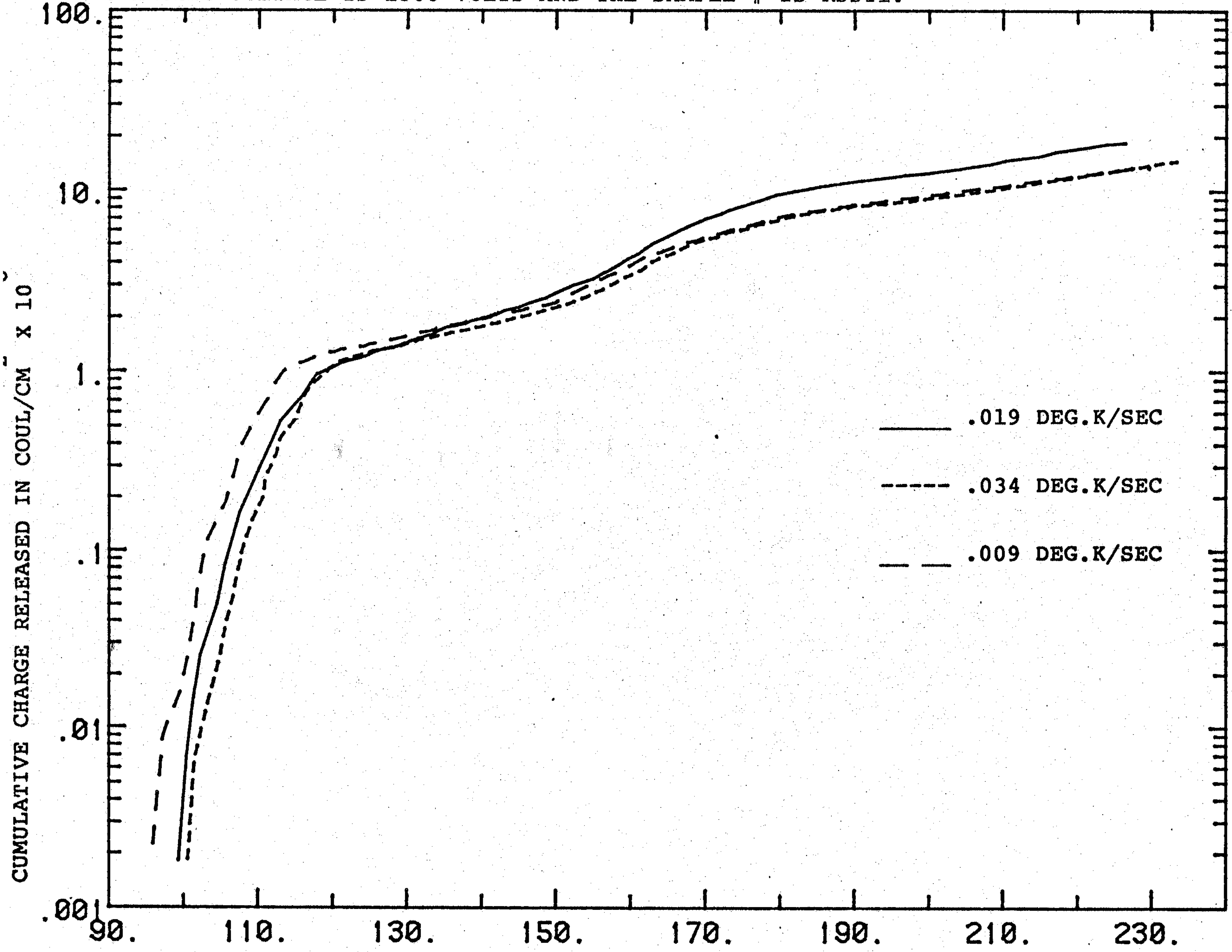
SEMI-LOG PLOT OF TSD RUNS, OF THE SAME SAMPLE, RUN AT DIFFERENT HEATING RATES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE CHARGING VOLTAGE IS 1500 VOLTS AND THE SAMPLE # IS RSST1.



LINEAR PLOT OF TSD RUNS, OF THE SAME SAMPLE, RUN AT DIFFERENT HEATING RATES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE CHARGING VOLTAGE IS 1500 VOLTS AND THE SAMPLE # IS RSST1.



SEMI-LOG PLOT OF THE CUMULATIVE CHARGE RELEASED, OF THE SAME SAMPLE RUN AT DIFFERENT HEATING RATES USING THE CONCENTRIC-CYLINDER SAMPLE HOLDER. THE CHARGING VOLTAGE IS 1500 VOLTS AND THE SAMPLE # IS RSST1.



APPENDIX V-COMPUTER MODEL RESULTS

THIS APPENDIX CONTAINS TSD PLOTS THAT COMPARE THE TSD DATA TO THE INVERSION PROGRAM MODEL RESULTS.

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST1, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

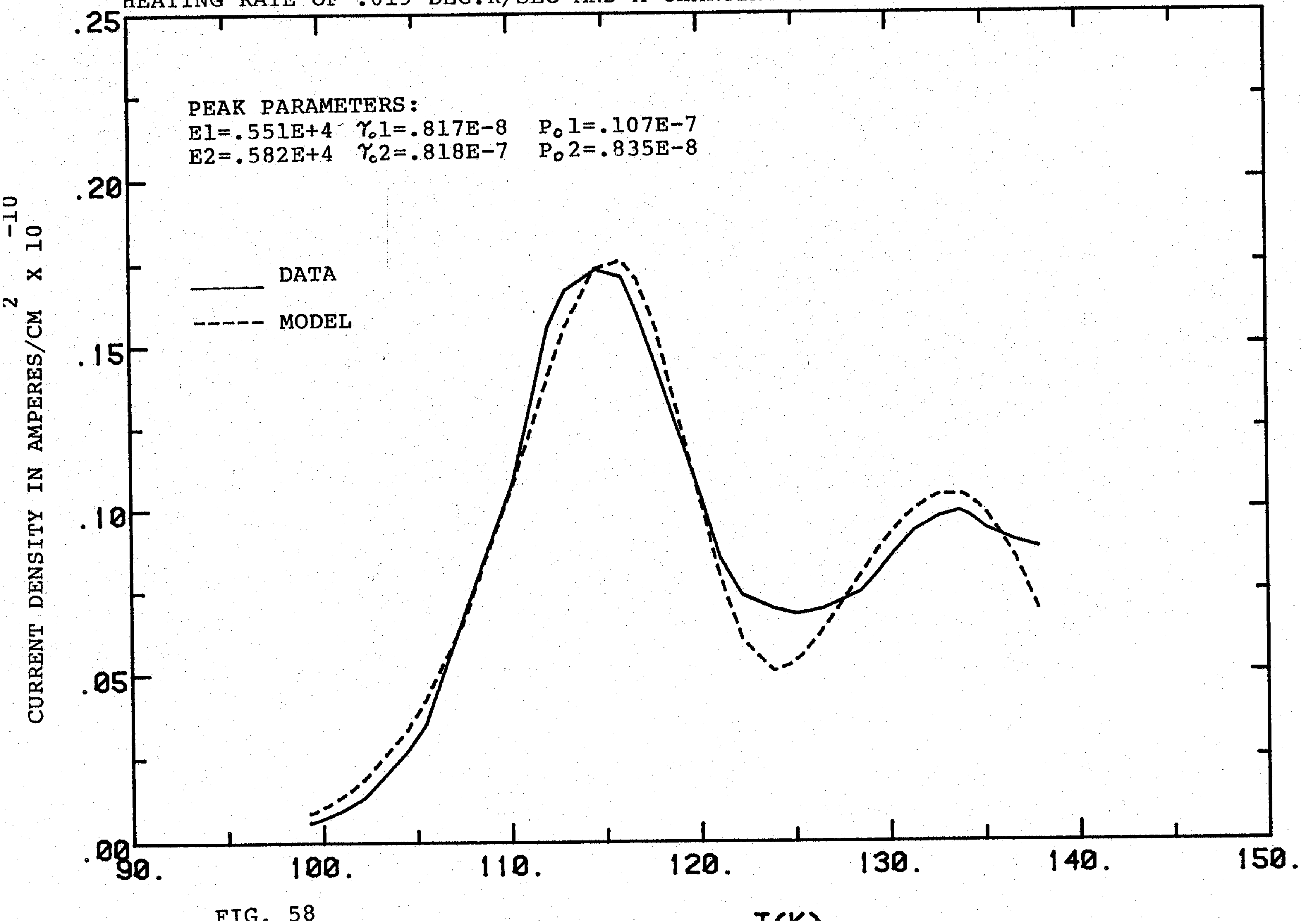


FIG. 58

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST2, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .008 DEG.K/SEC AND A CHARGING VOLTAGE OF 1900 VOLTS WAS USED.

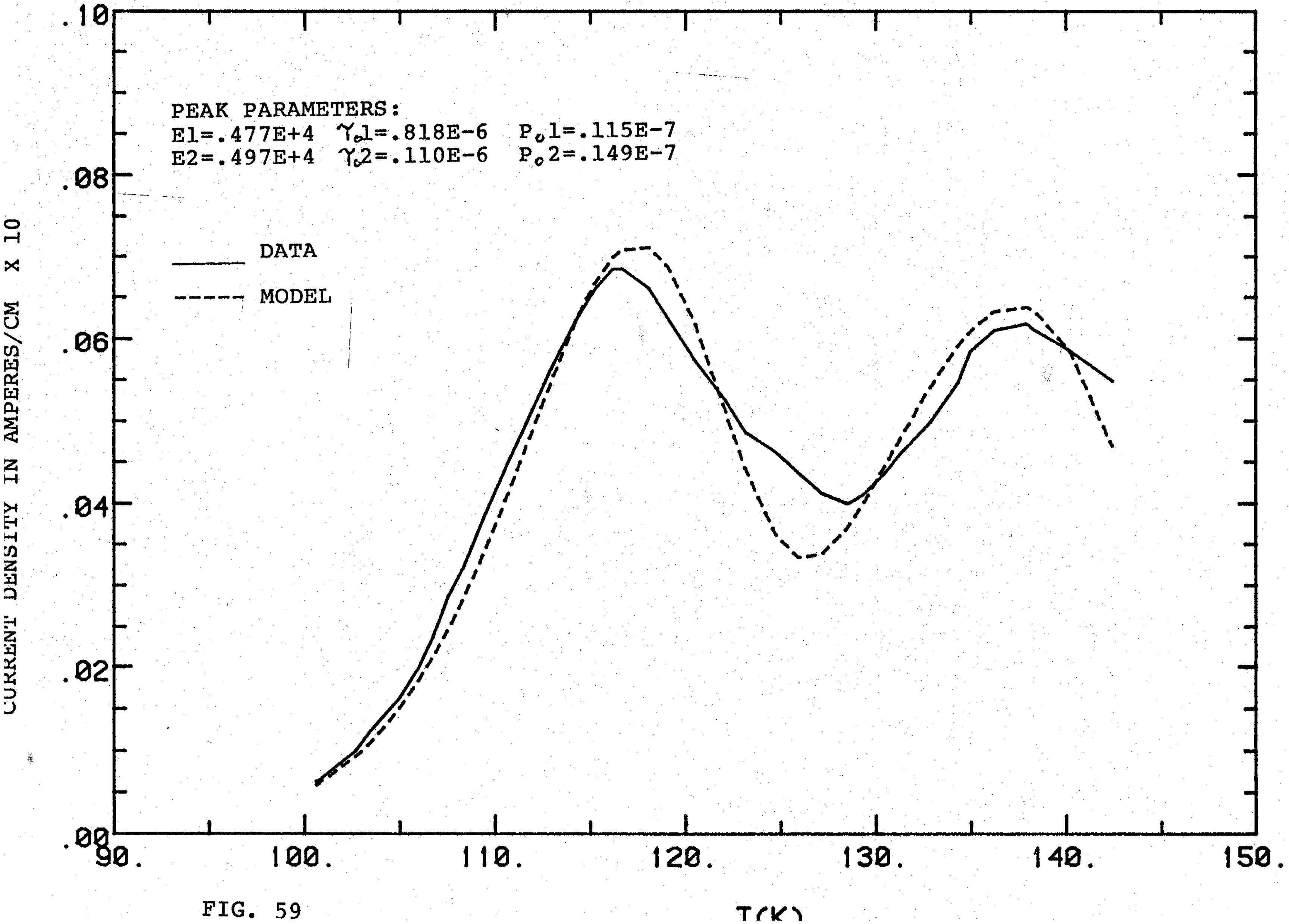


FIG. 59

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST3, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

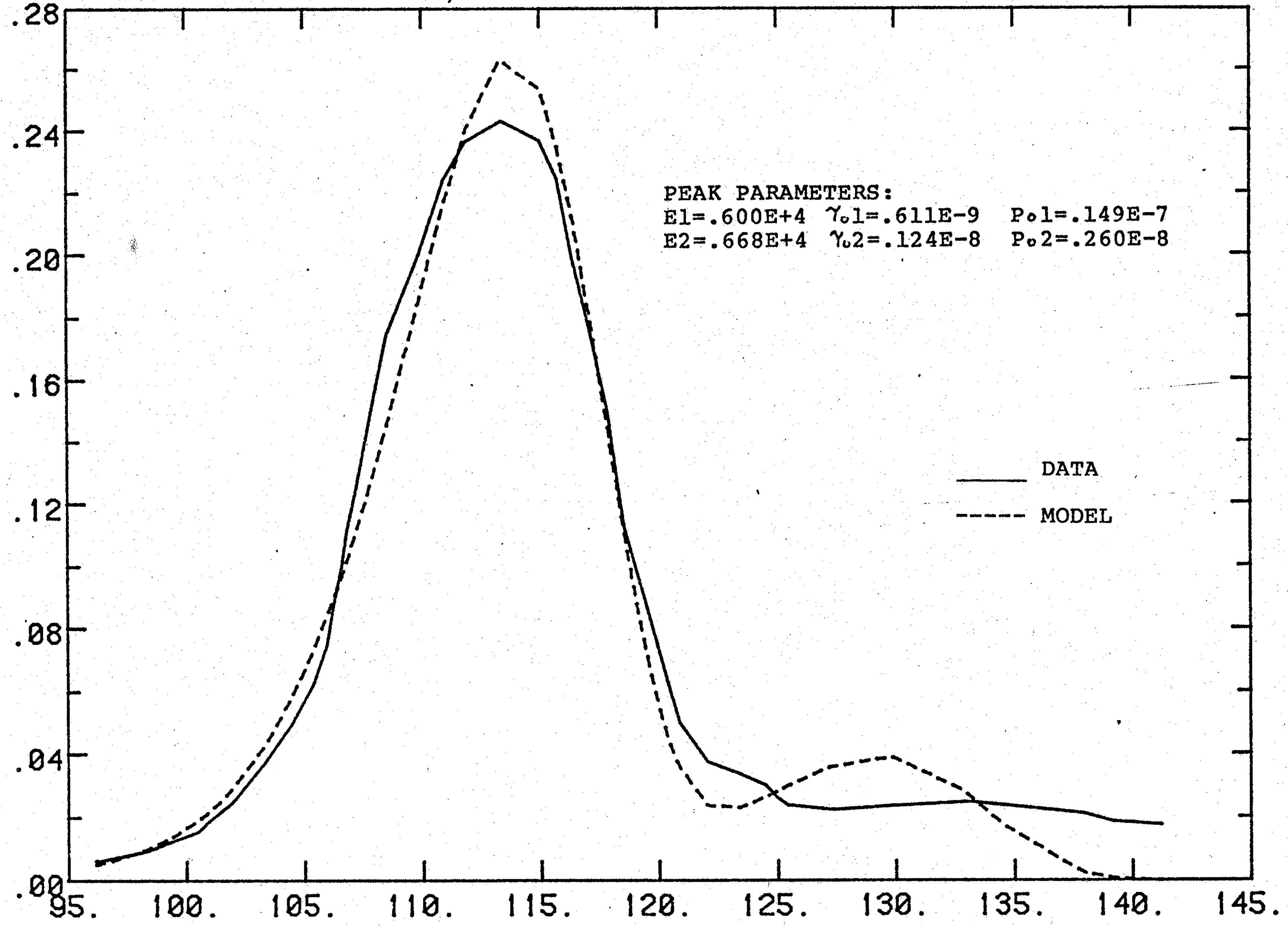


FIG. 60

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST6, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

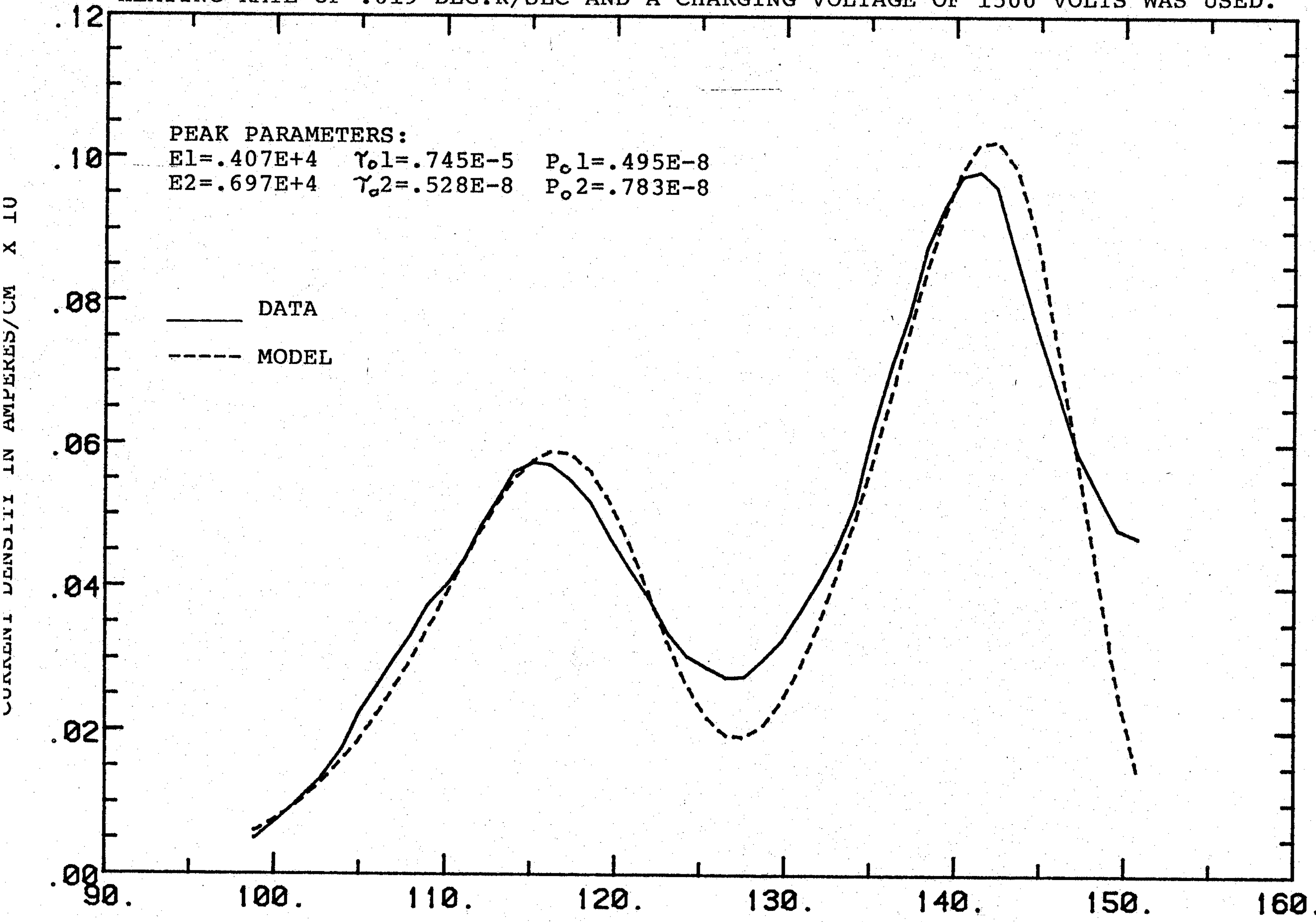


FIG. 61

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST7, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

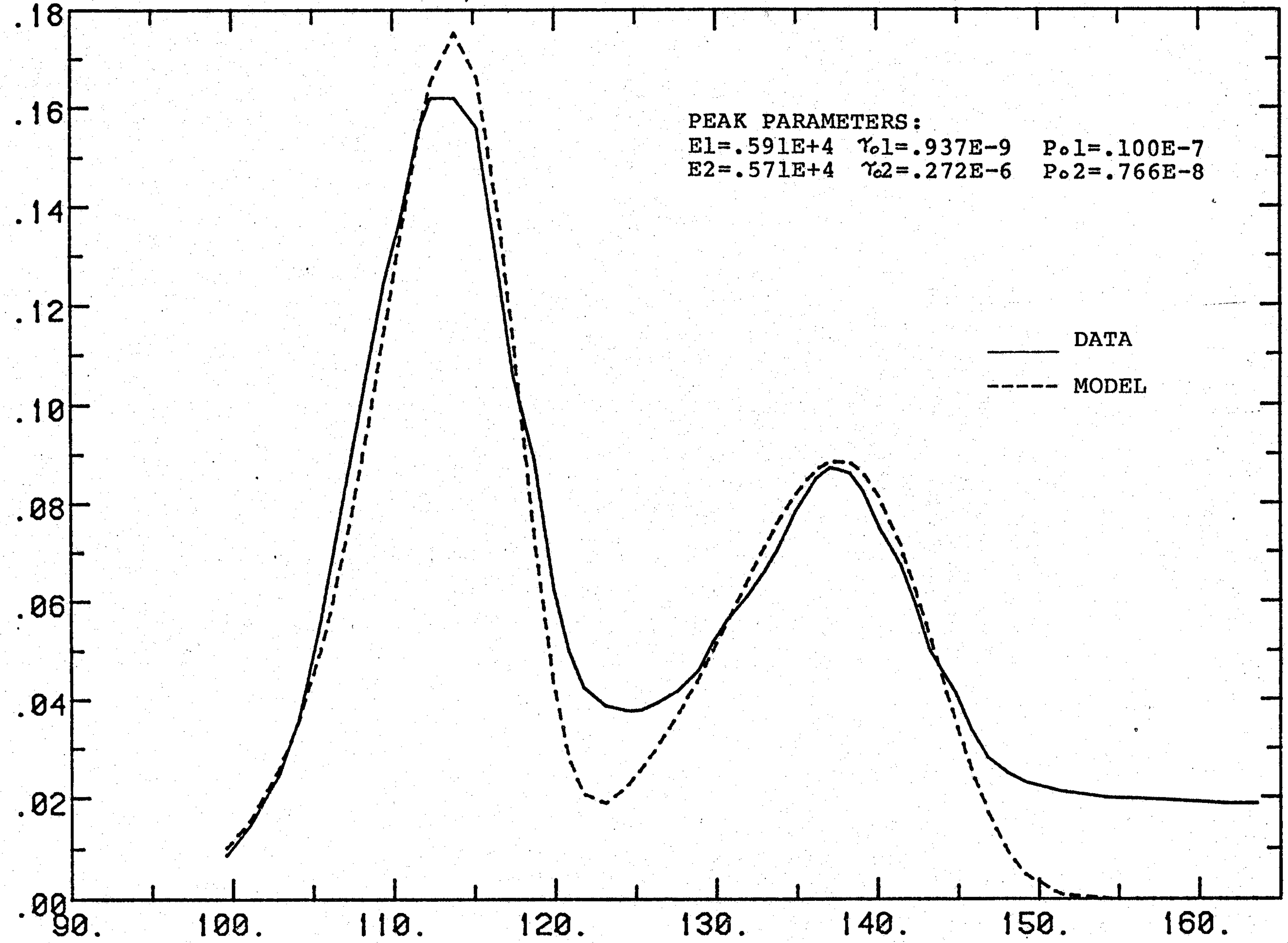


FIG. 62

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST8, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

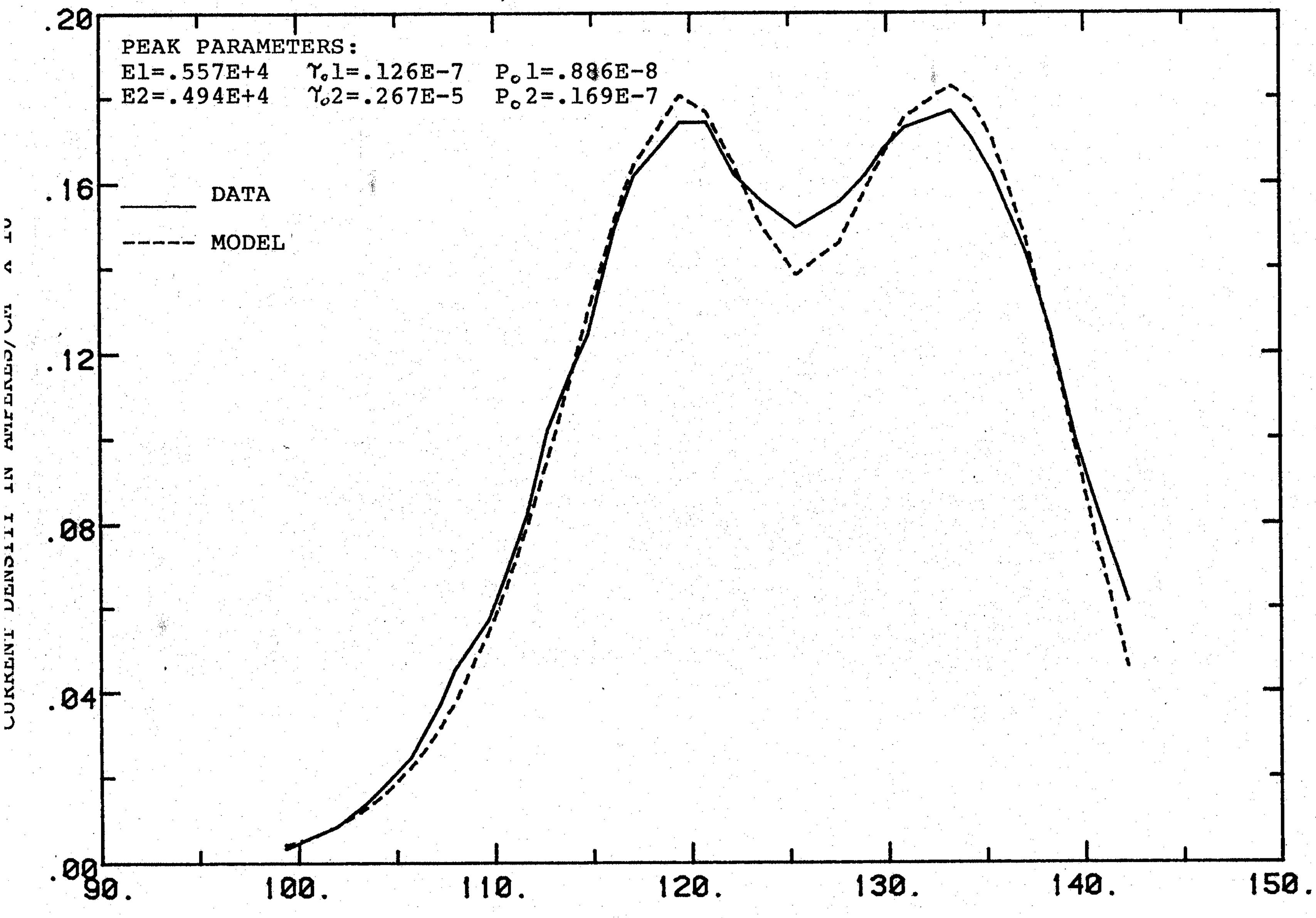


FIG. 63

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE THIRD REFREEZE OF SAMPLE # RSST8, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

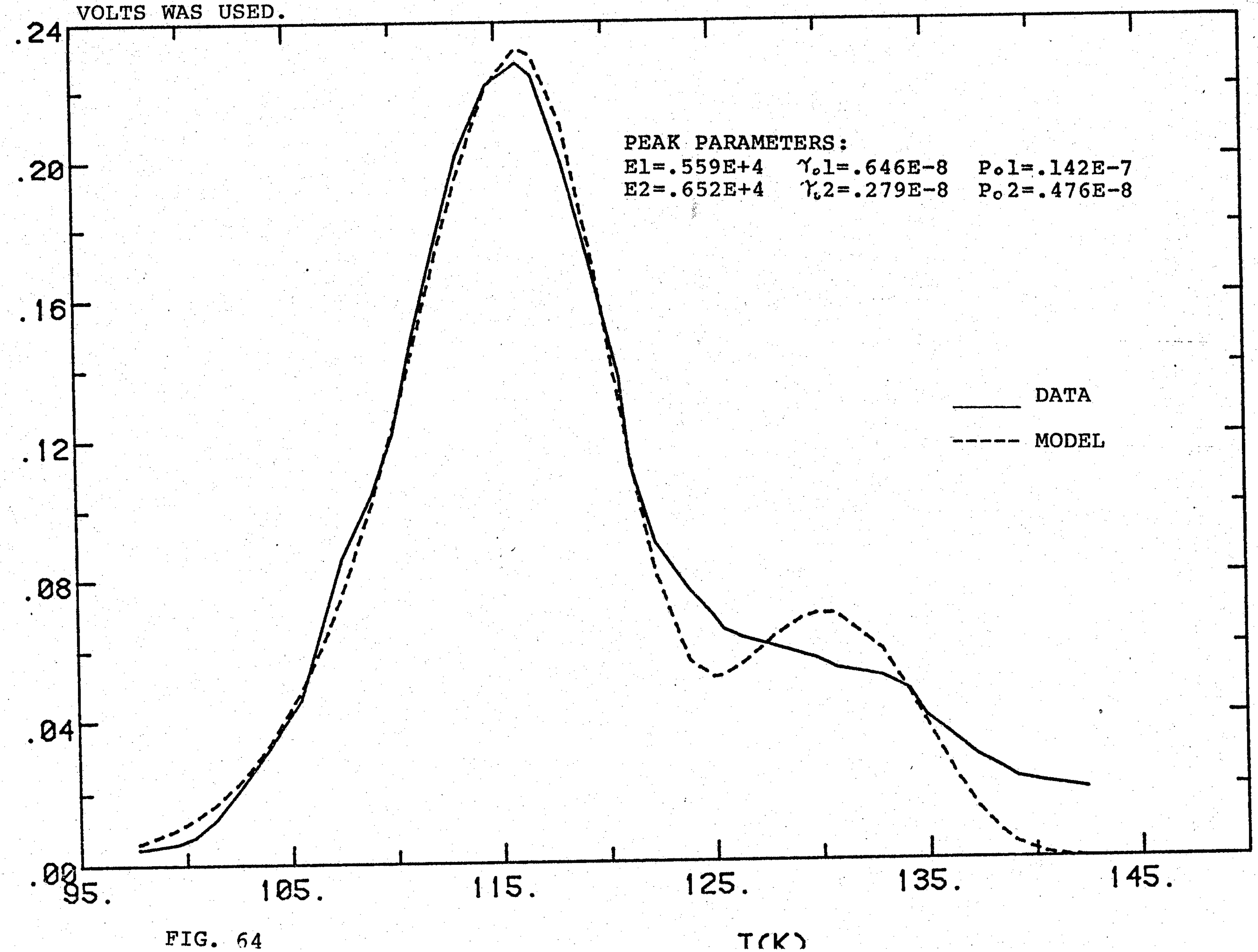


FIG. 64

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST9, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

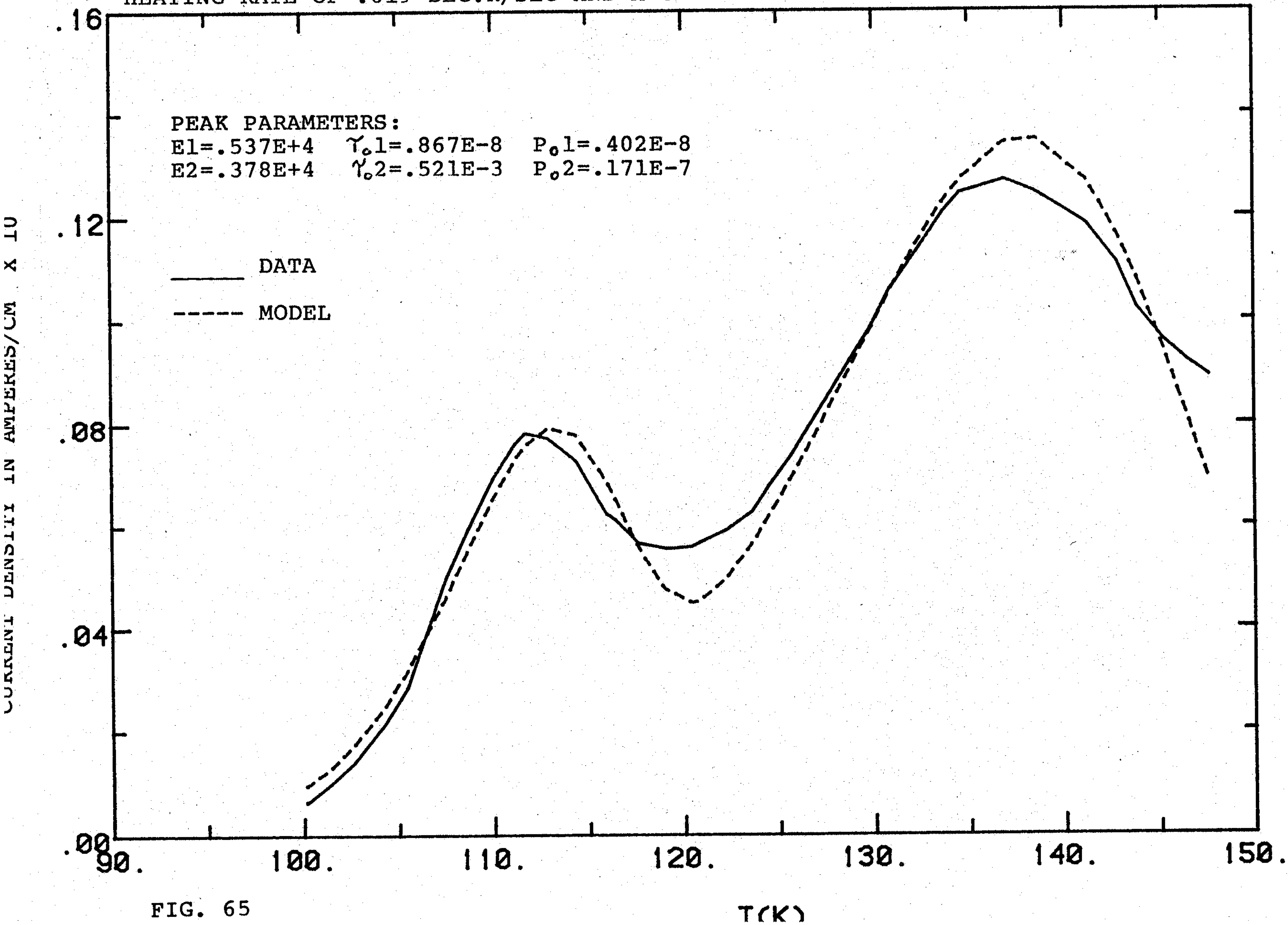


FIG. 65

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE THIRD REFREEZE OF SAMPLE # RSST9, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

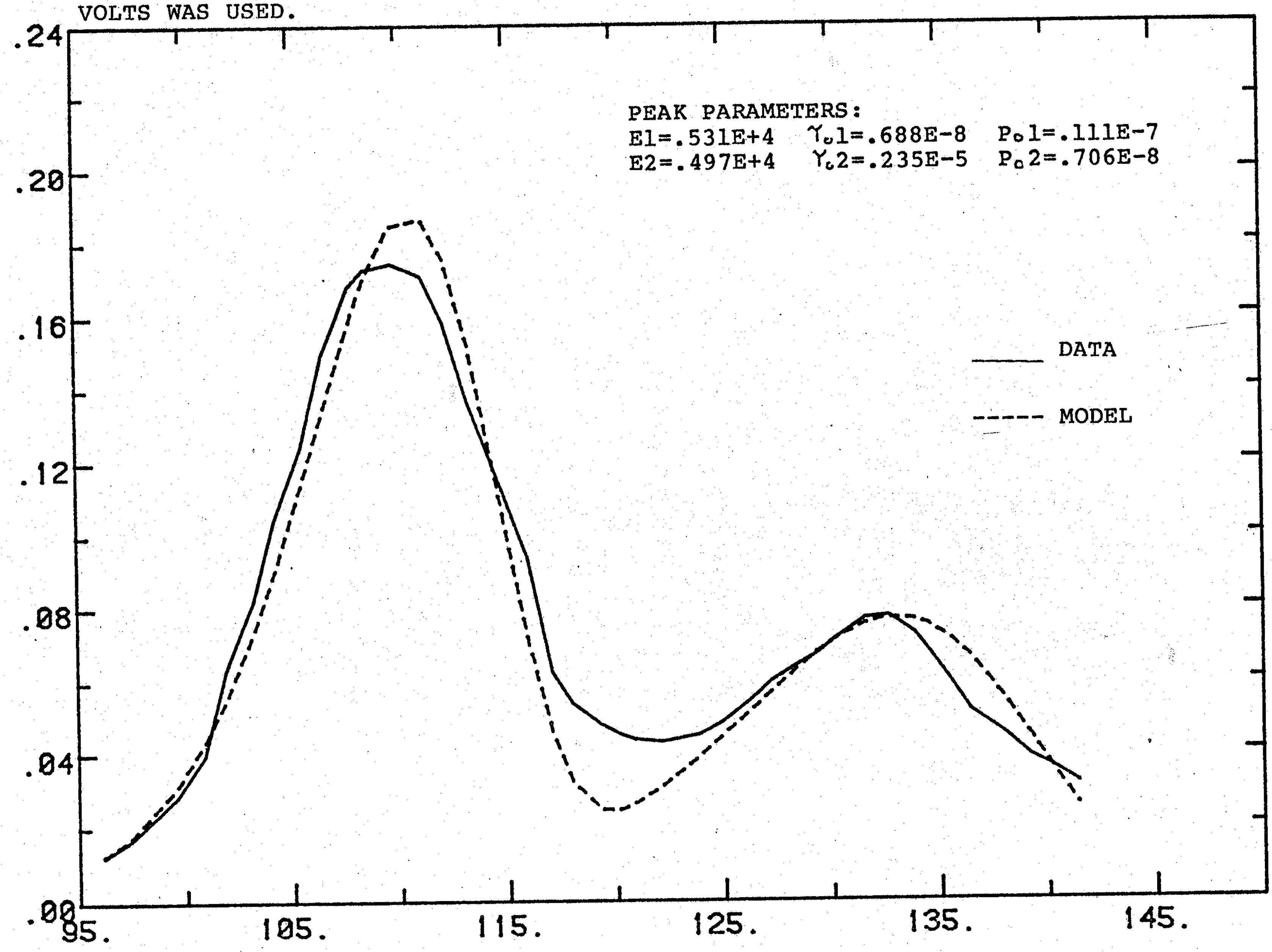


FIG. 66

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE FOURTH REFREEZE OF SAMPLE # RSST9, WHICH WAS FROZEN UNDER CARBON DIOXIDE IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

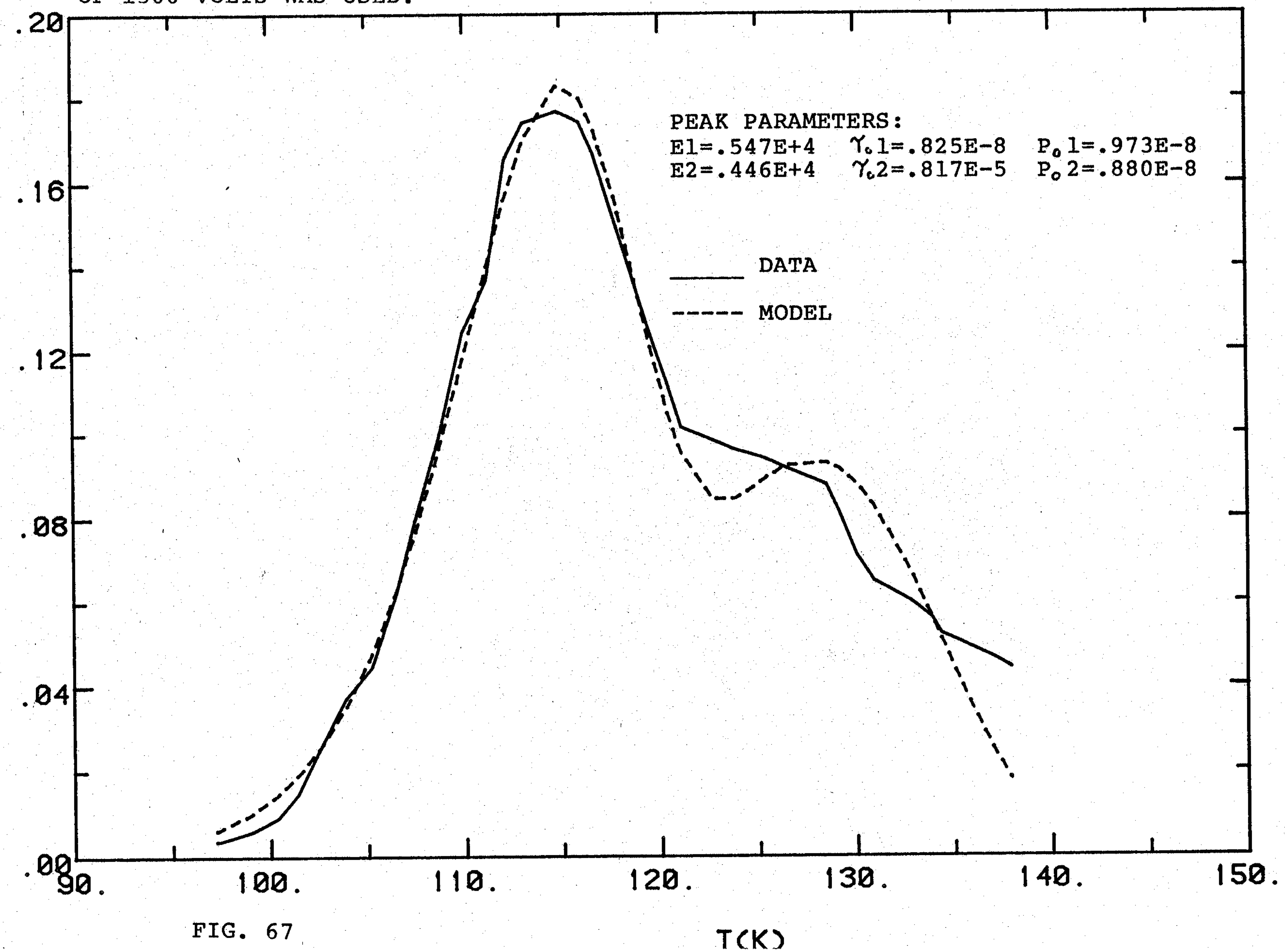


FIG. 67

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST10, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

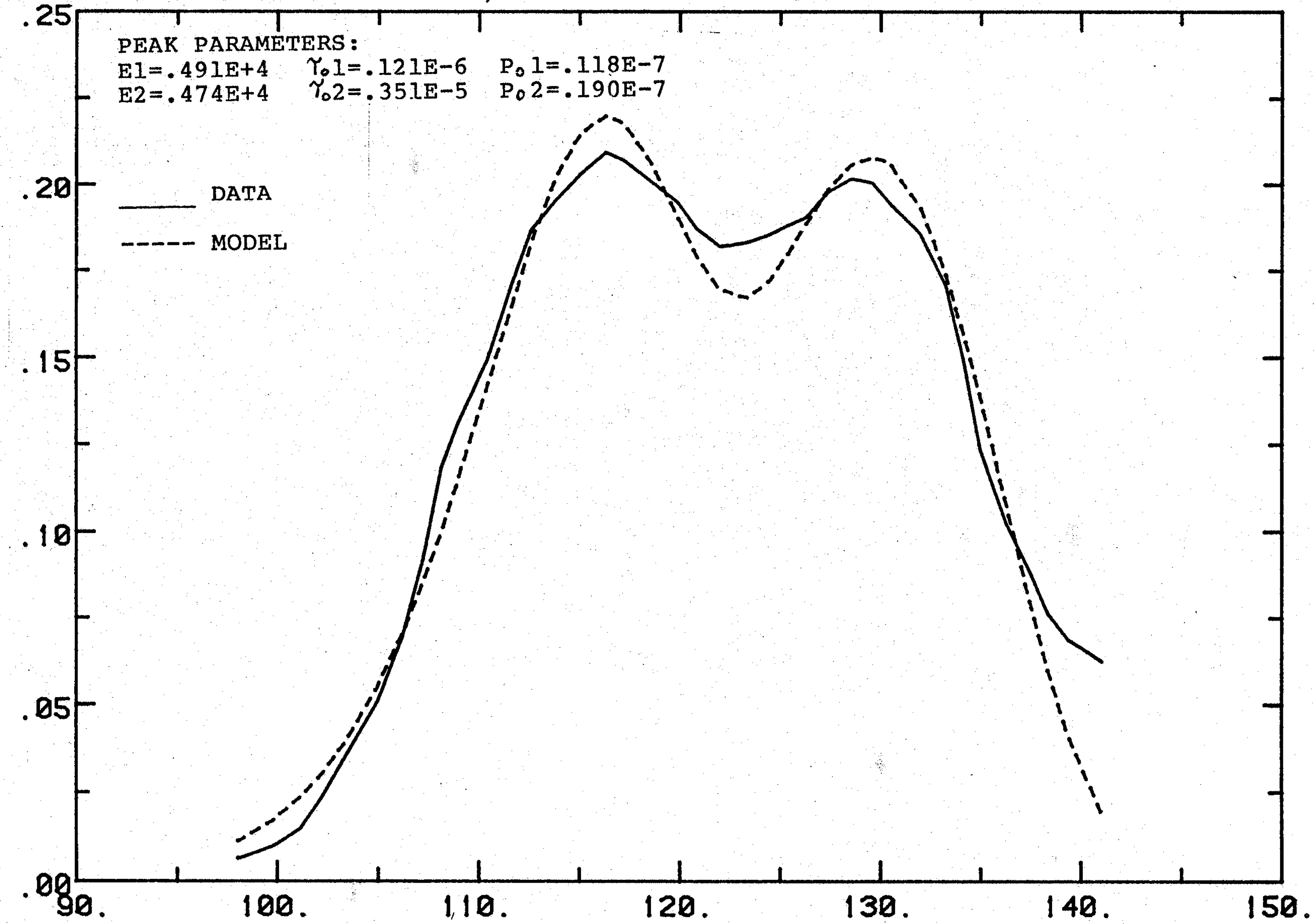


FIG. 68

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE THIRD REFREEZE OF SAMPLE # RSST10, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

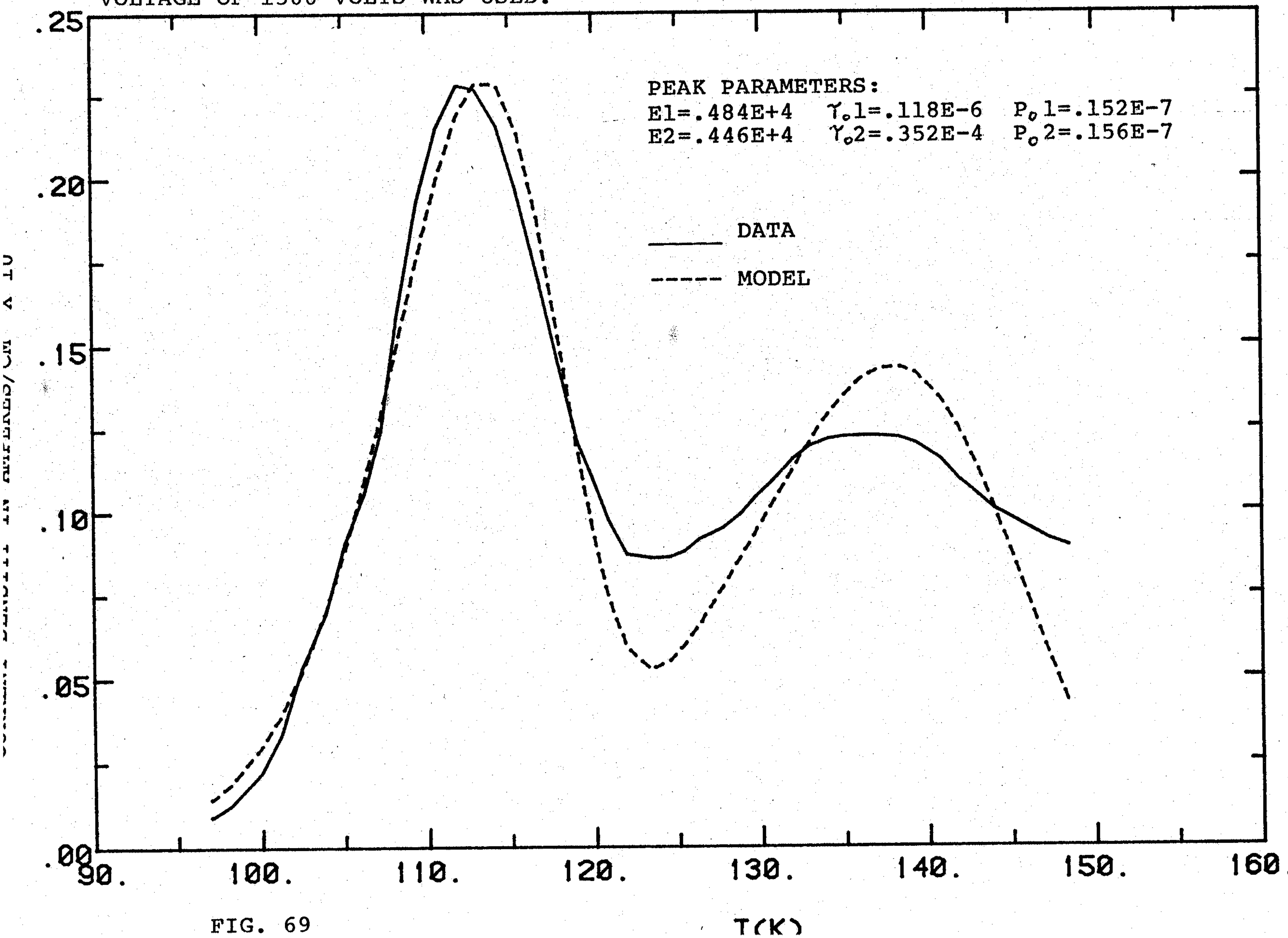


FIG. 69

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RSST11, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

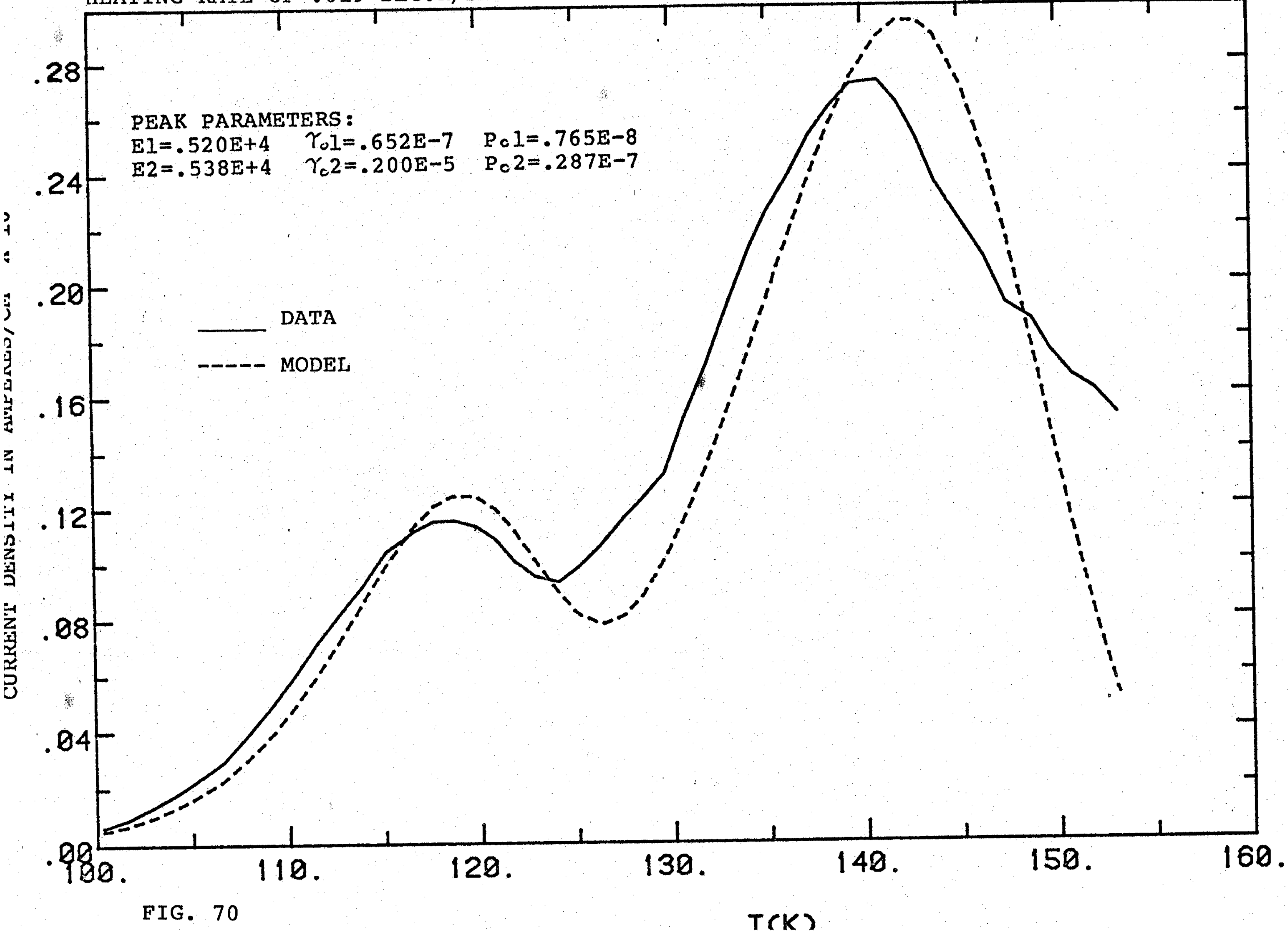


FIG. 70

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE THIRD REFREEZE OF SAMPLE # RSST11, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

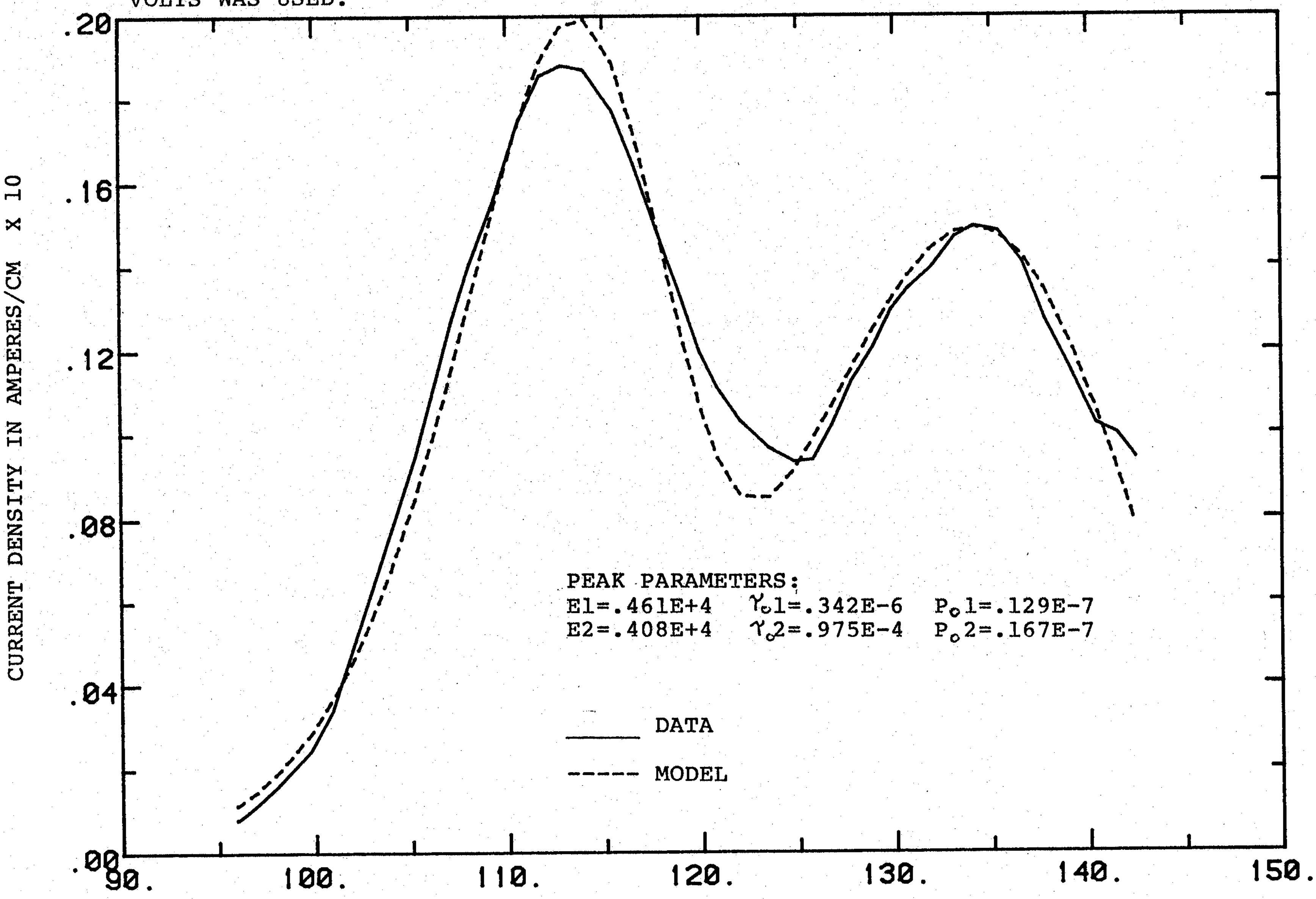


FIG. 71

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE FIFTH REFREEZE OF SAMPLE # RSST11, WHICH WAS FROZEN UNDER CARBON DIOXIDE IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

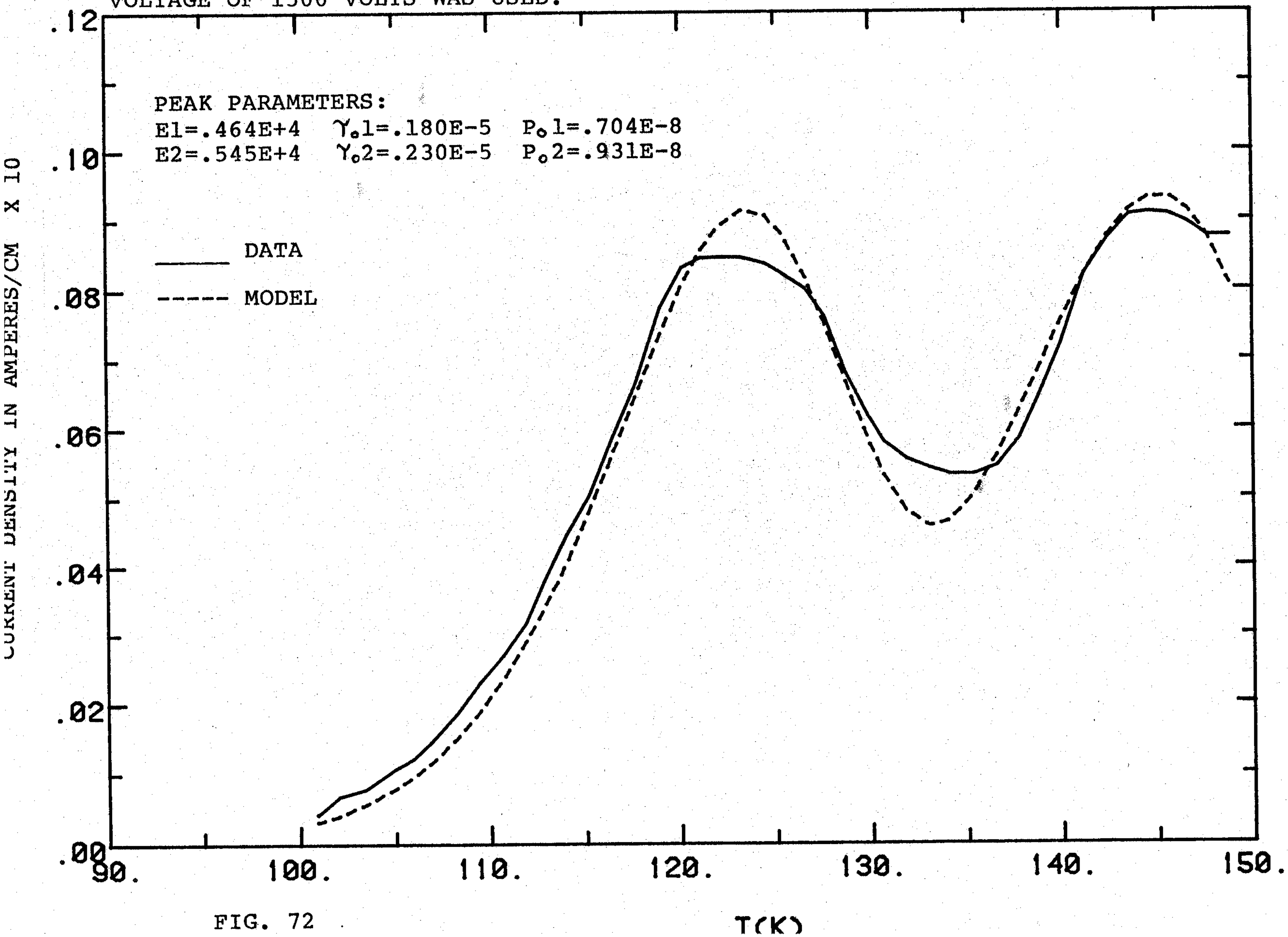


FIG. 72

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE FOURTH REFREEZE OF SAMPLE # RSST12, WHICH WAS FROZEN UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

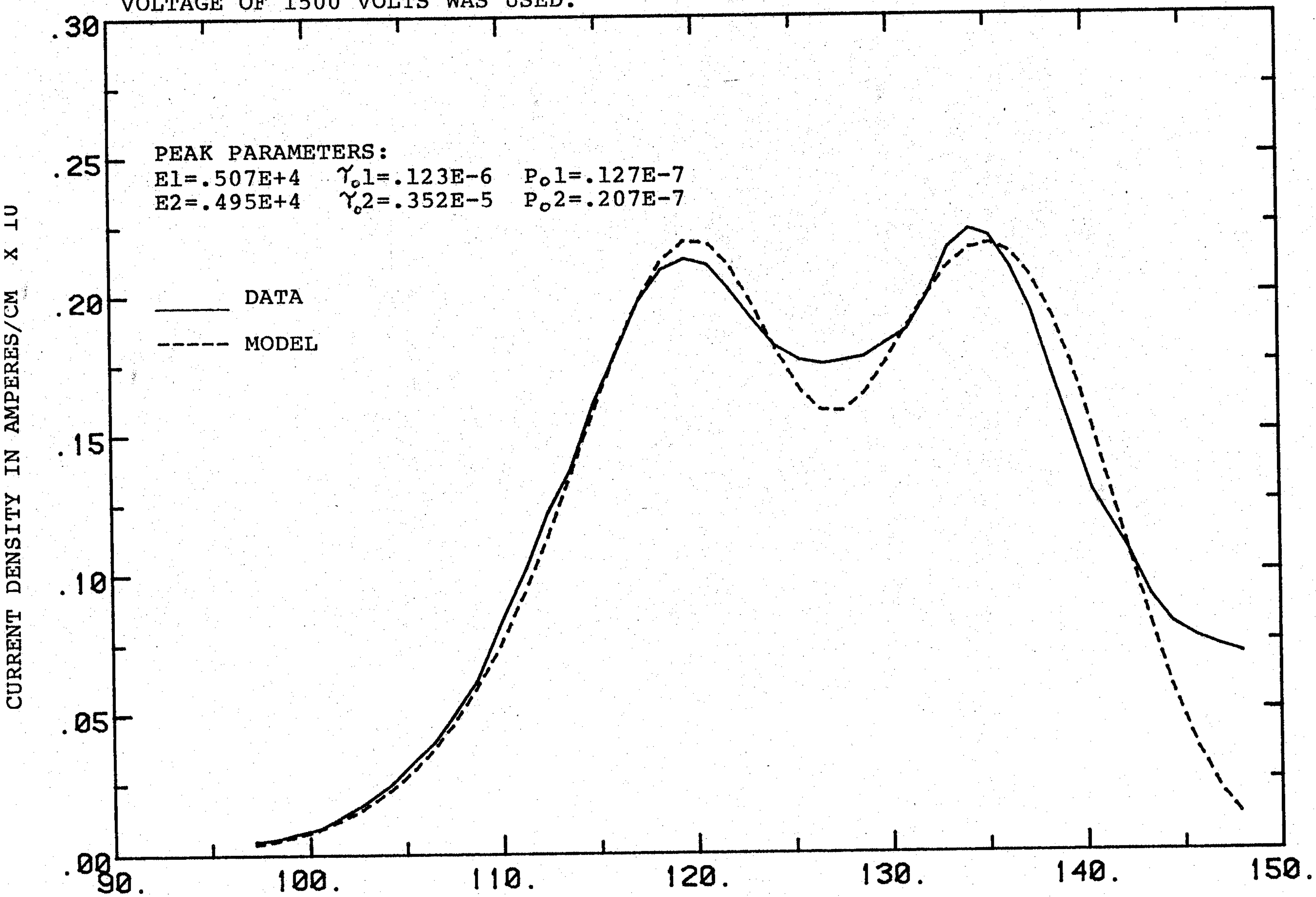
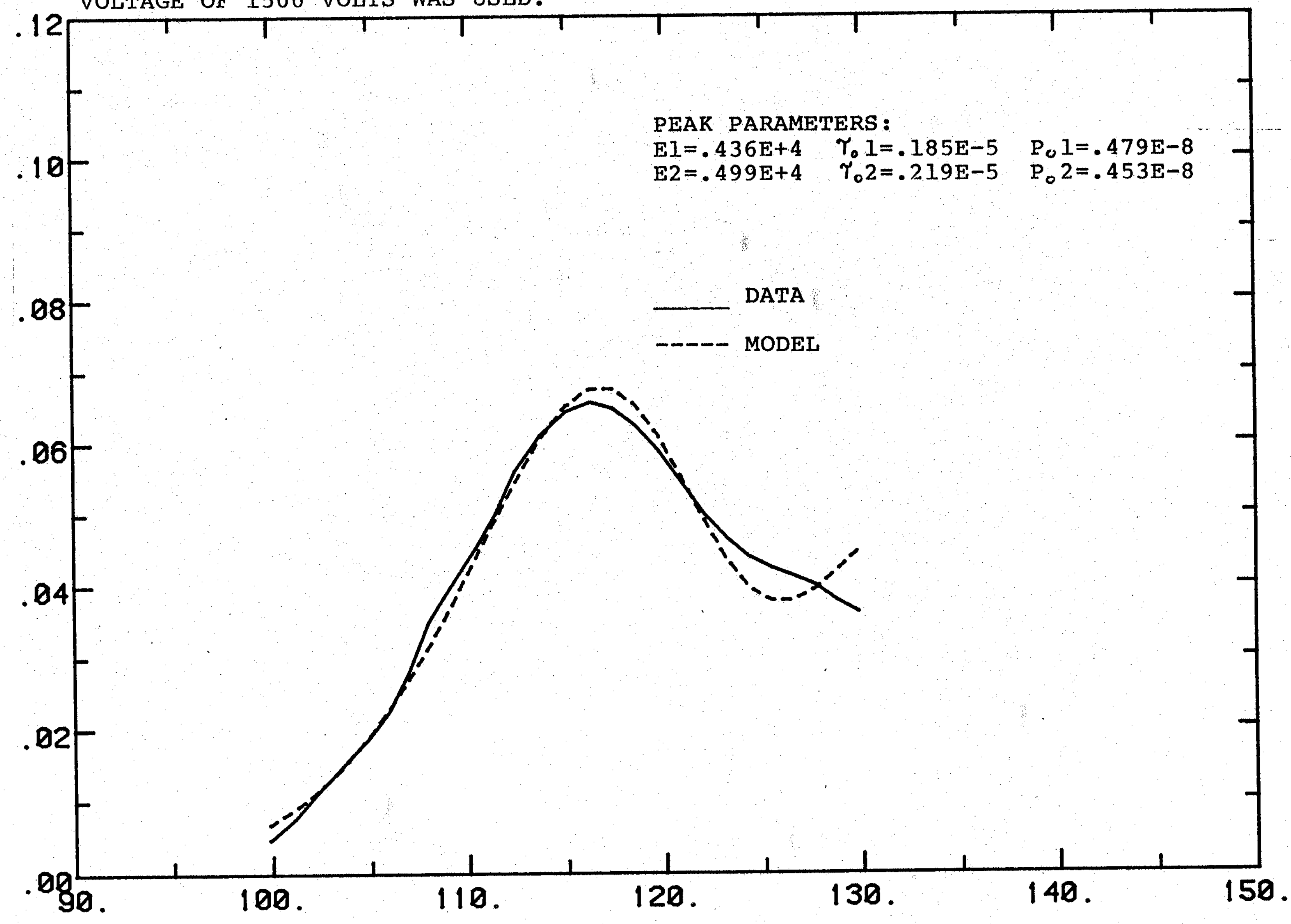


FIG. 73

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE SIXTH REFREEZE OF SAMPLE # RSST12, WHICH WAS FROZEN UNDER CARBON DIOXIDE IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.



A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RTF1, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

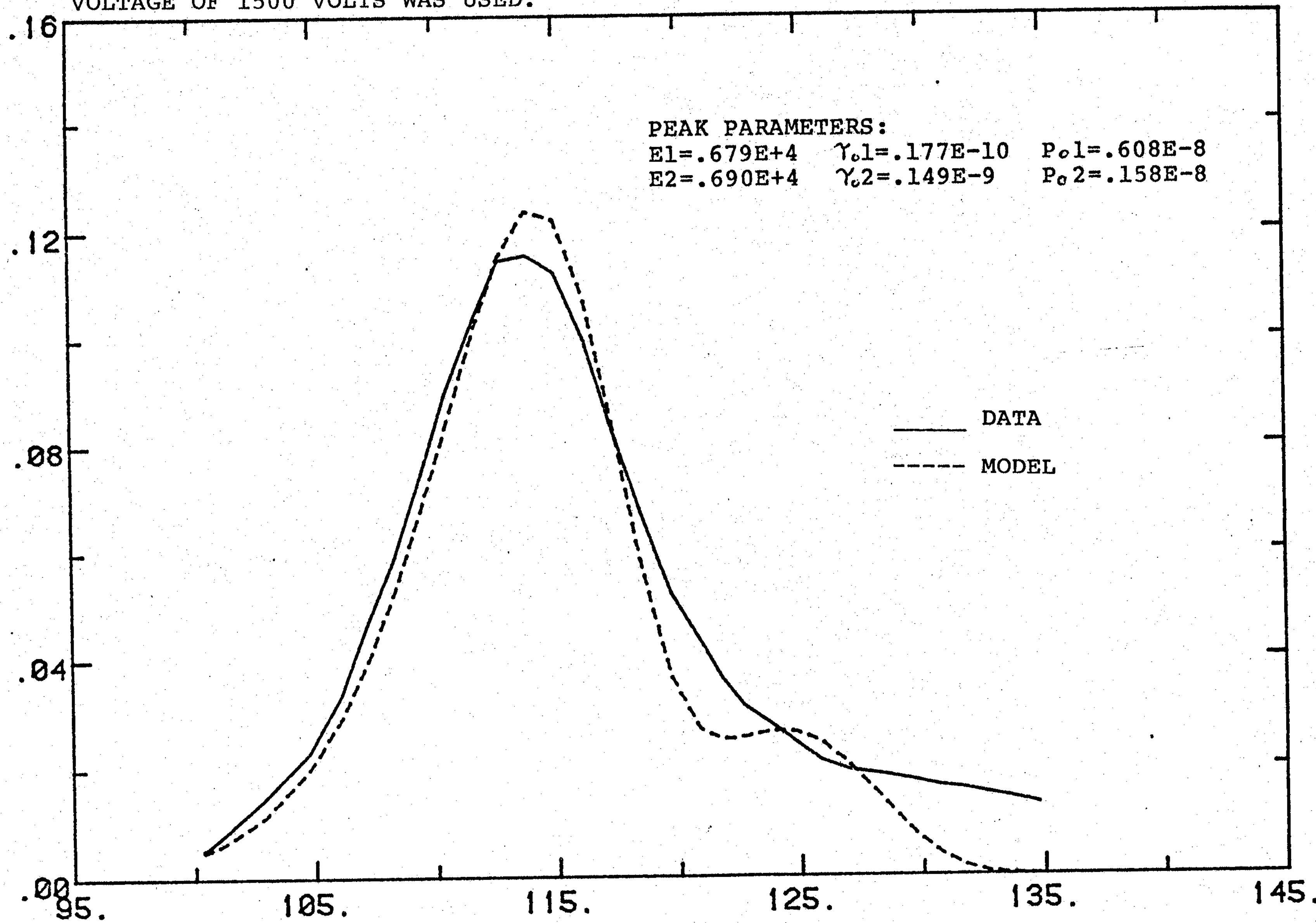


FIG. 75

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RTF2, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

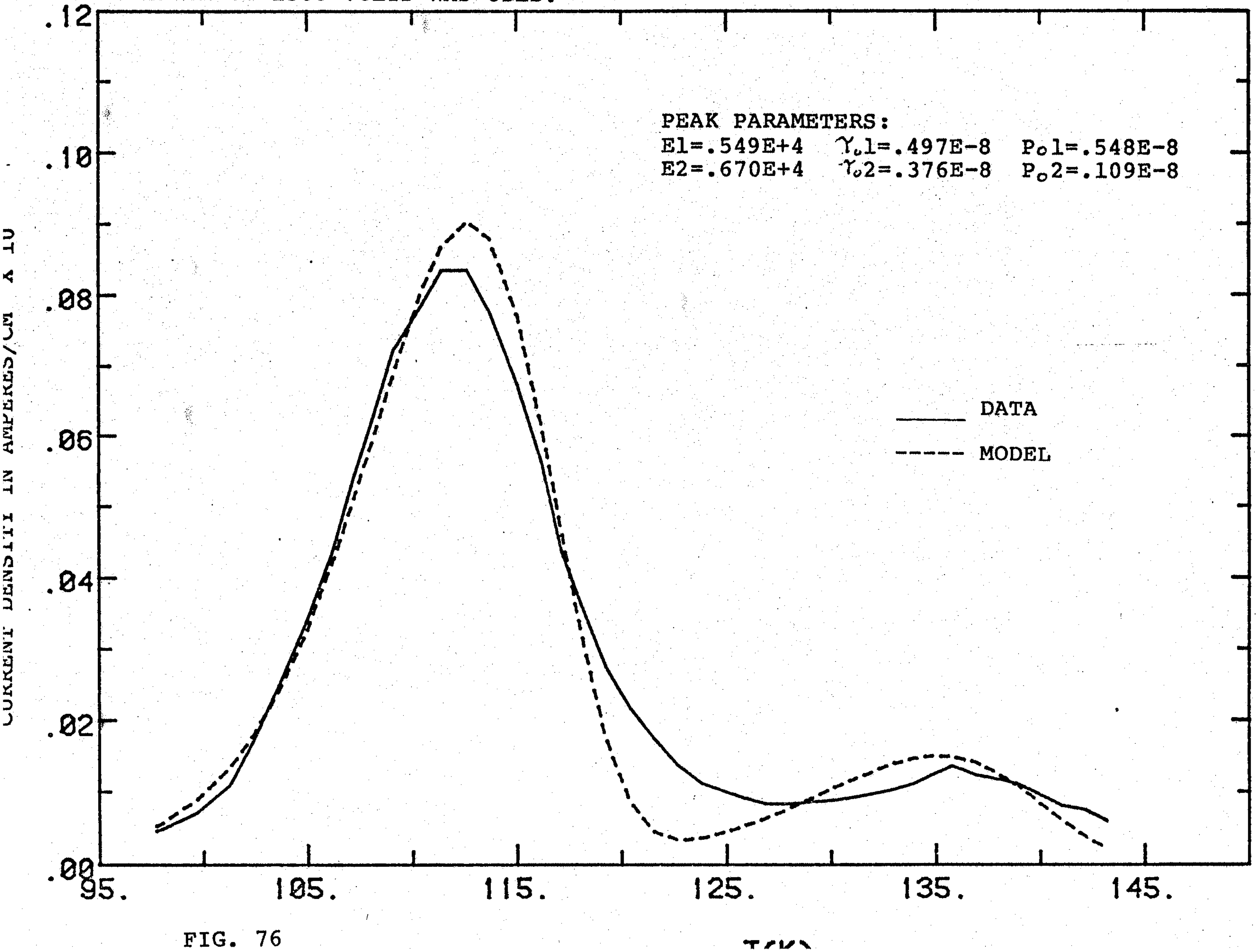


FIG. 76

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RTF3, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

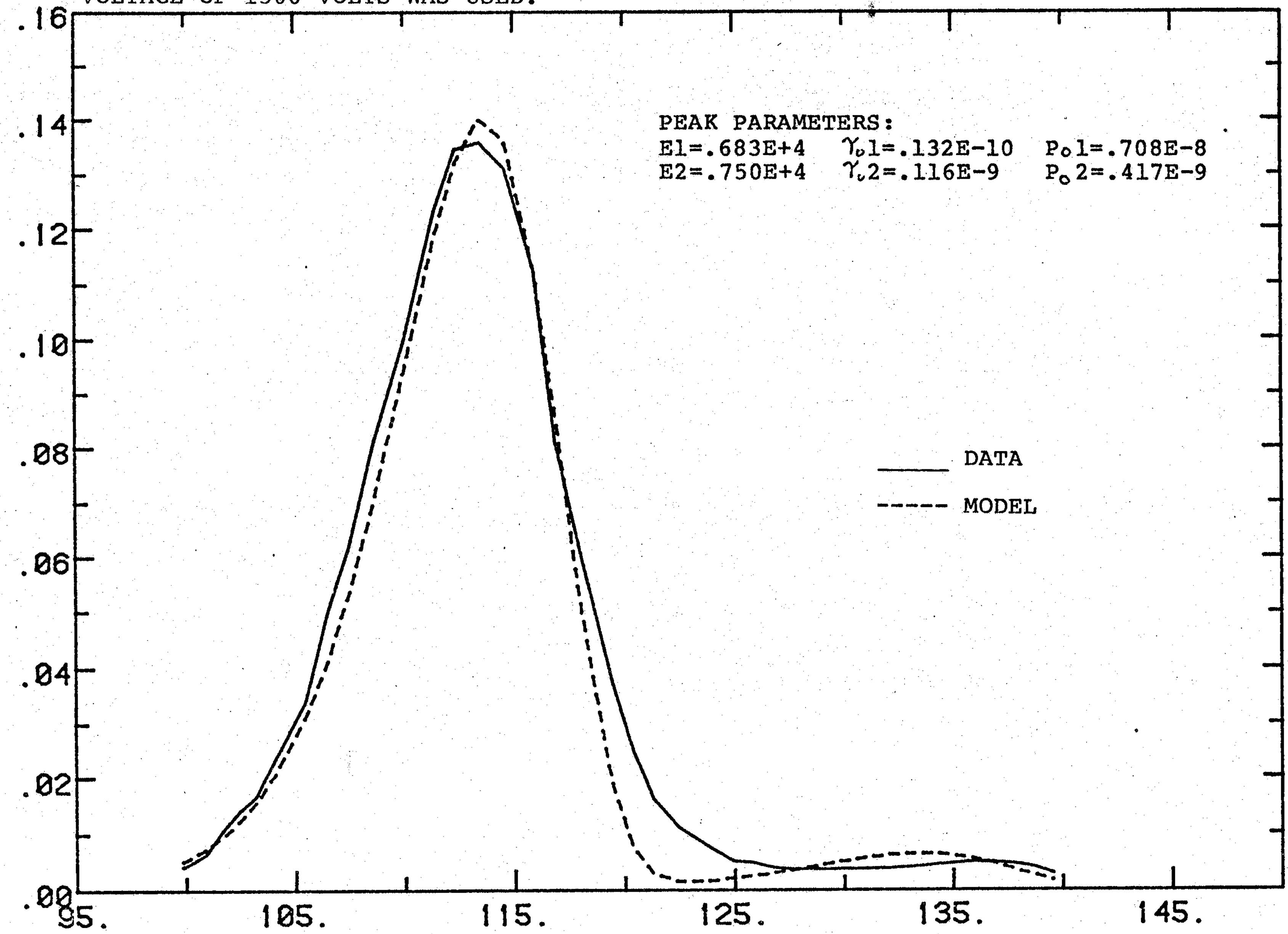


FIG. 77

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RTF4, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

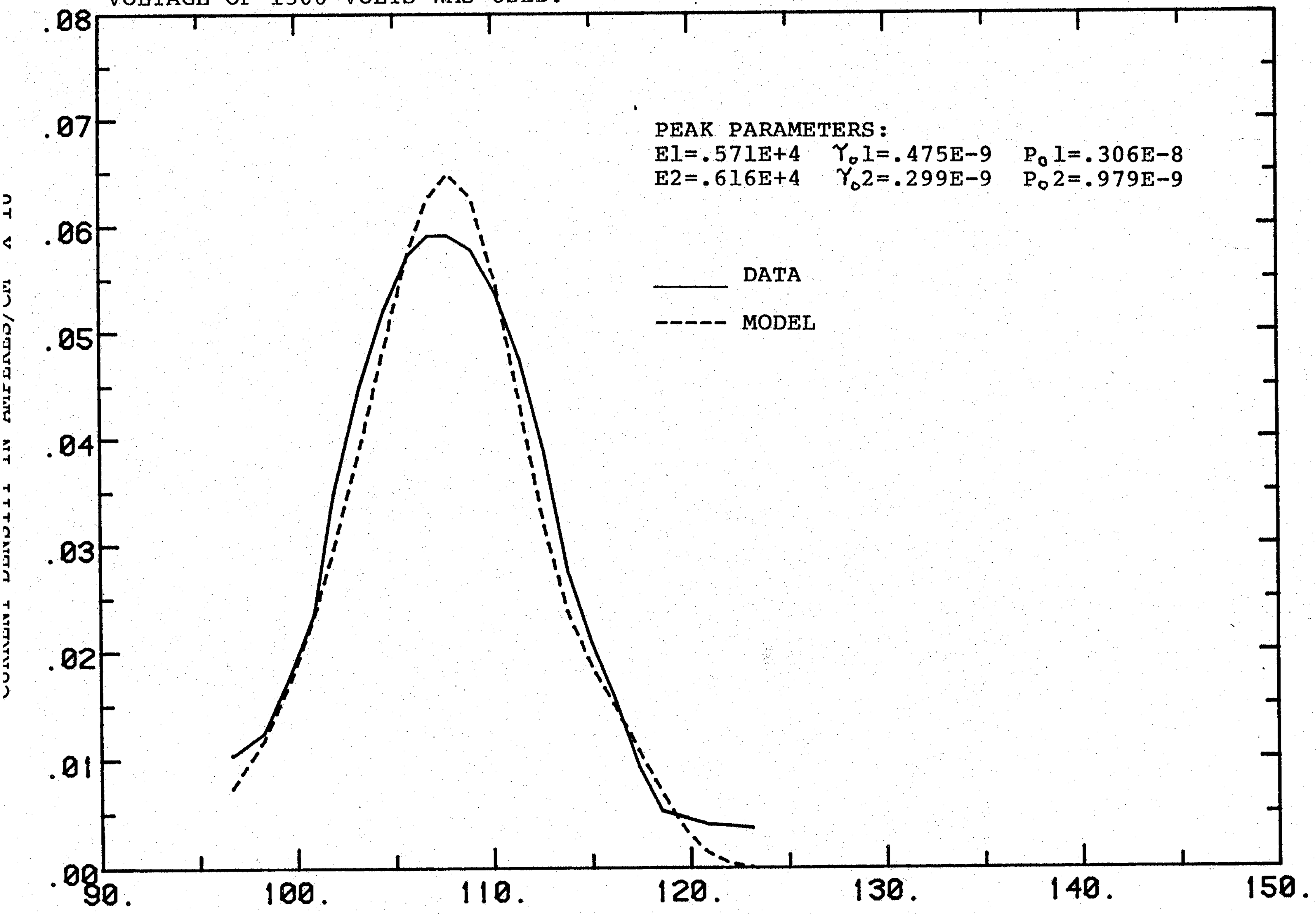


FIG. 78

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE SECOND REFREEZE OF SAMPLE # RTF4, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

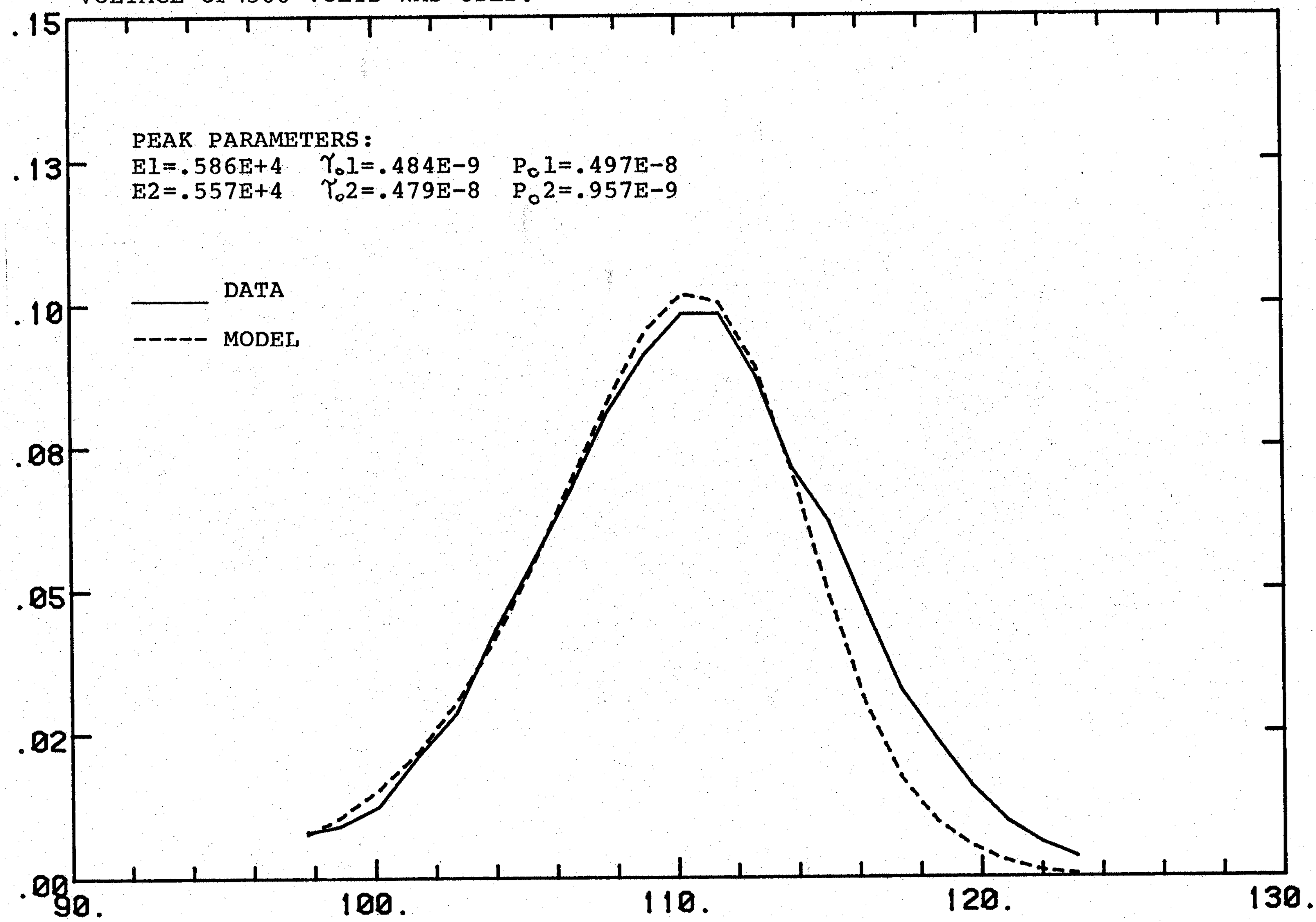


FIG. 79

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR THE THIRD REFREEZE OF SAMPLE # RTF4, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER CARBON DIOXIDE IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

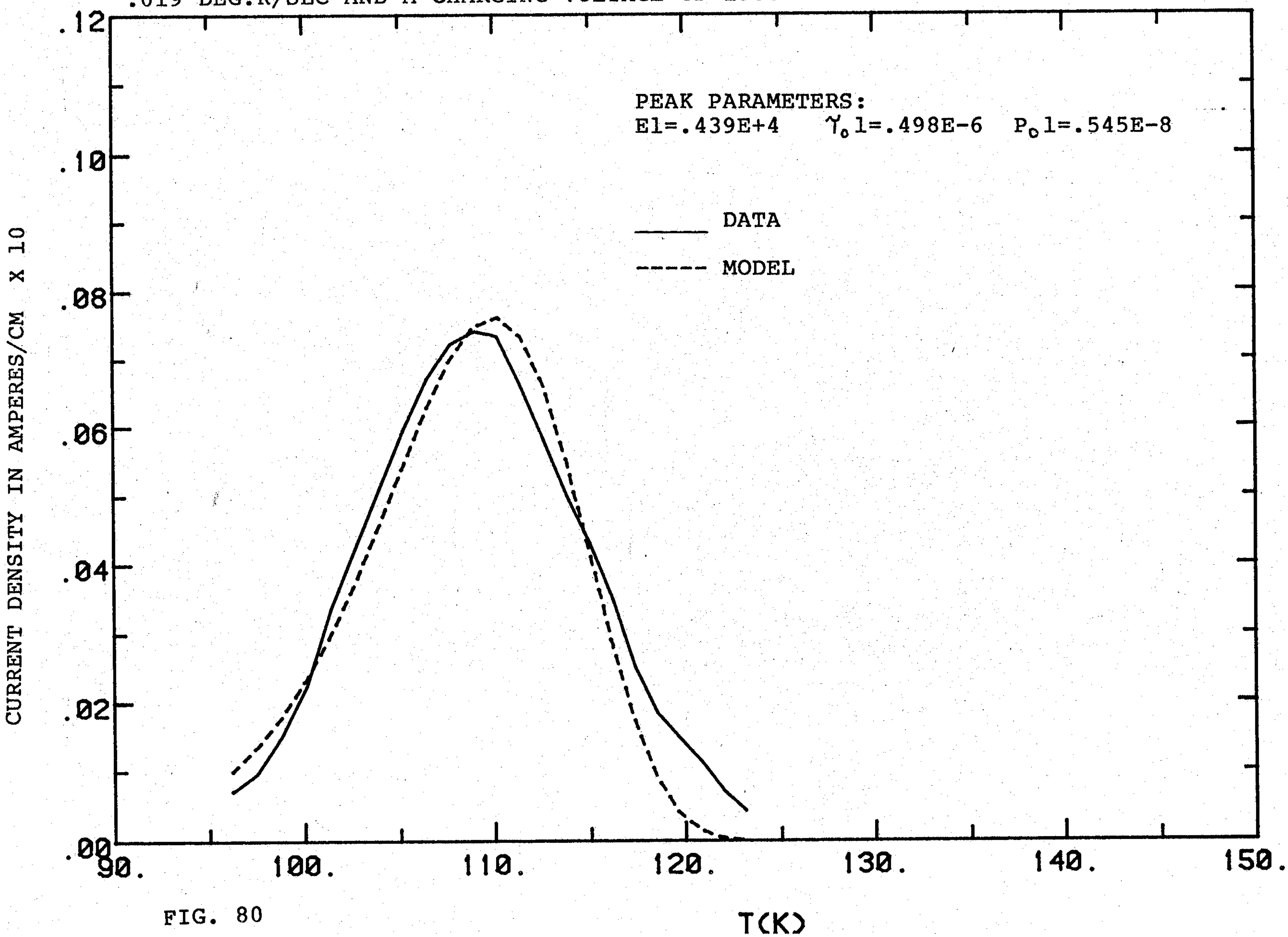


FIG. 80

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RTF5, WHICH WAS FROZEN WITH TEFON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

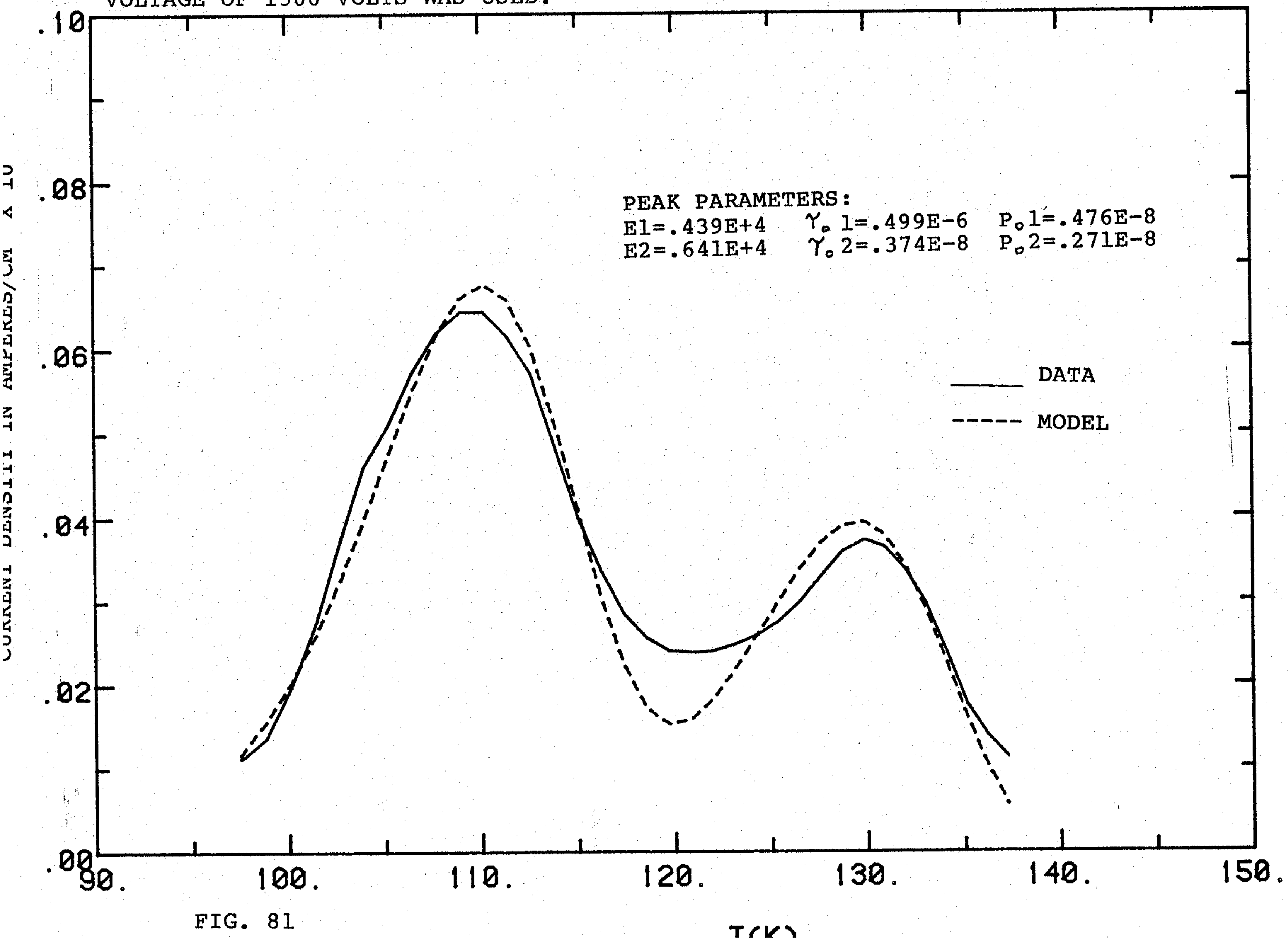


FIG. 81

A COMPARISON OF THE TSD DATA AND MODEL RESULTS OF THE THIRD REFREEZE OF SAMPLE # RTF5, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

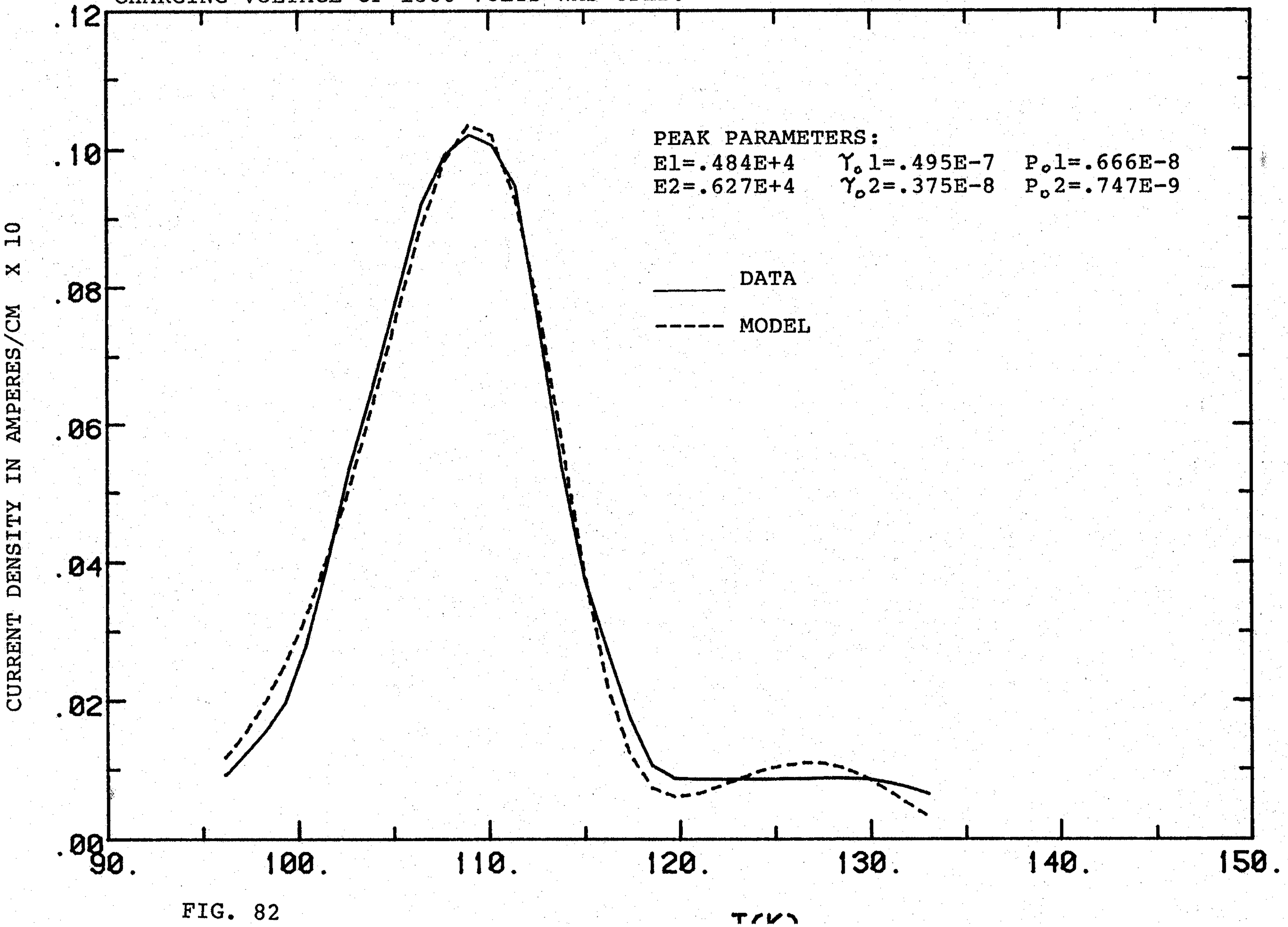


FIG. 82

A COMPARISON OF THE TSD DATA AND MODEL RESULTS OF THE FOURTH REFREEZE OF SAMPLE # RTF5, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER CARBON DIOXIDE IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

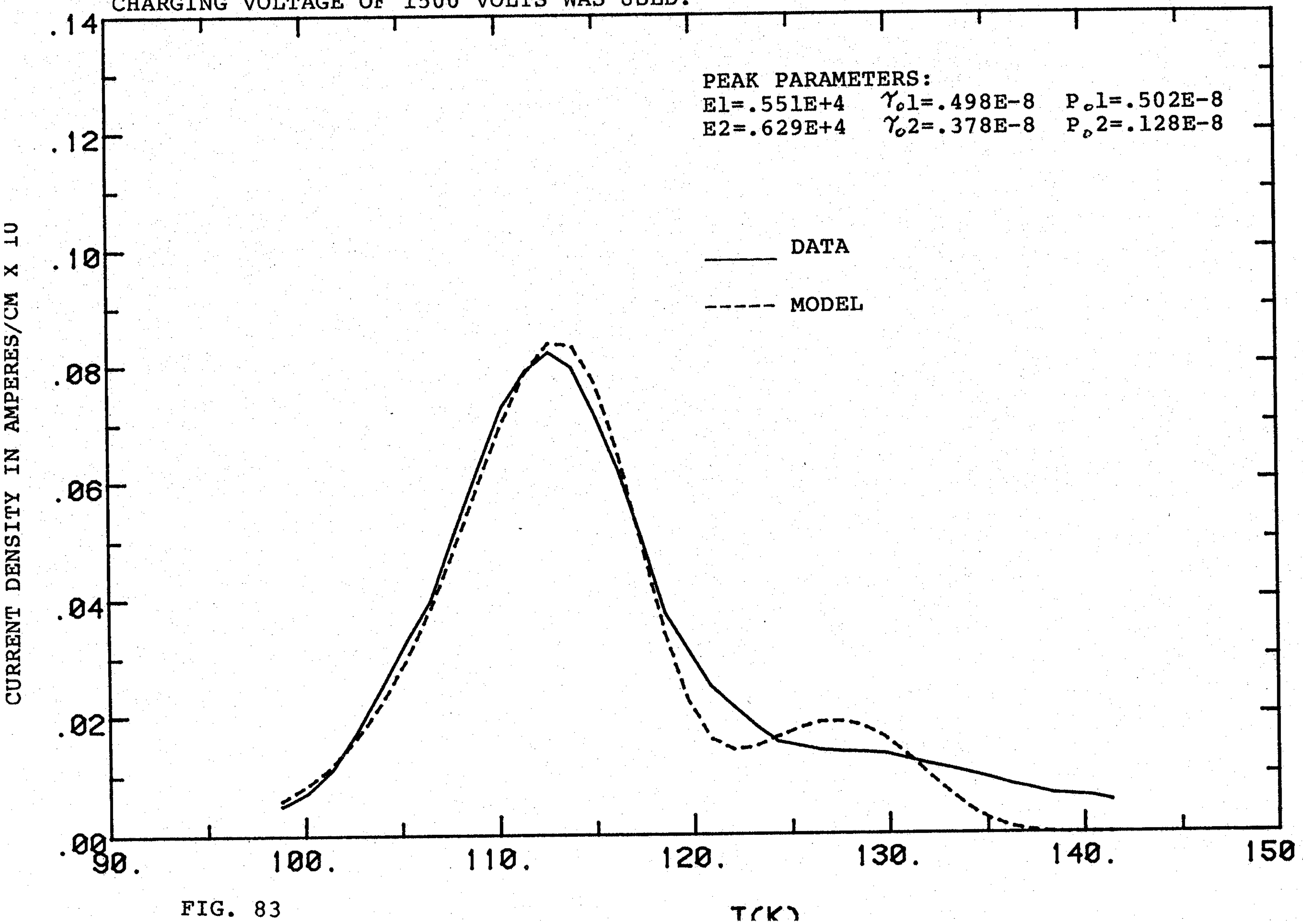


FIG. 83

A COMPARISON OF THE TSD DATA AND MODEL RESULTS FOR SAMPLE # RTF6, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

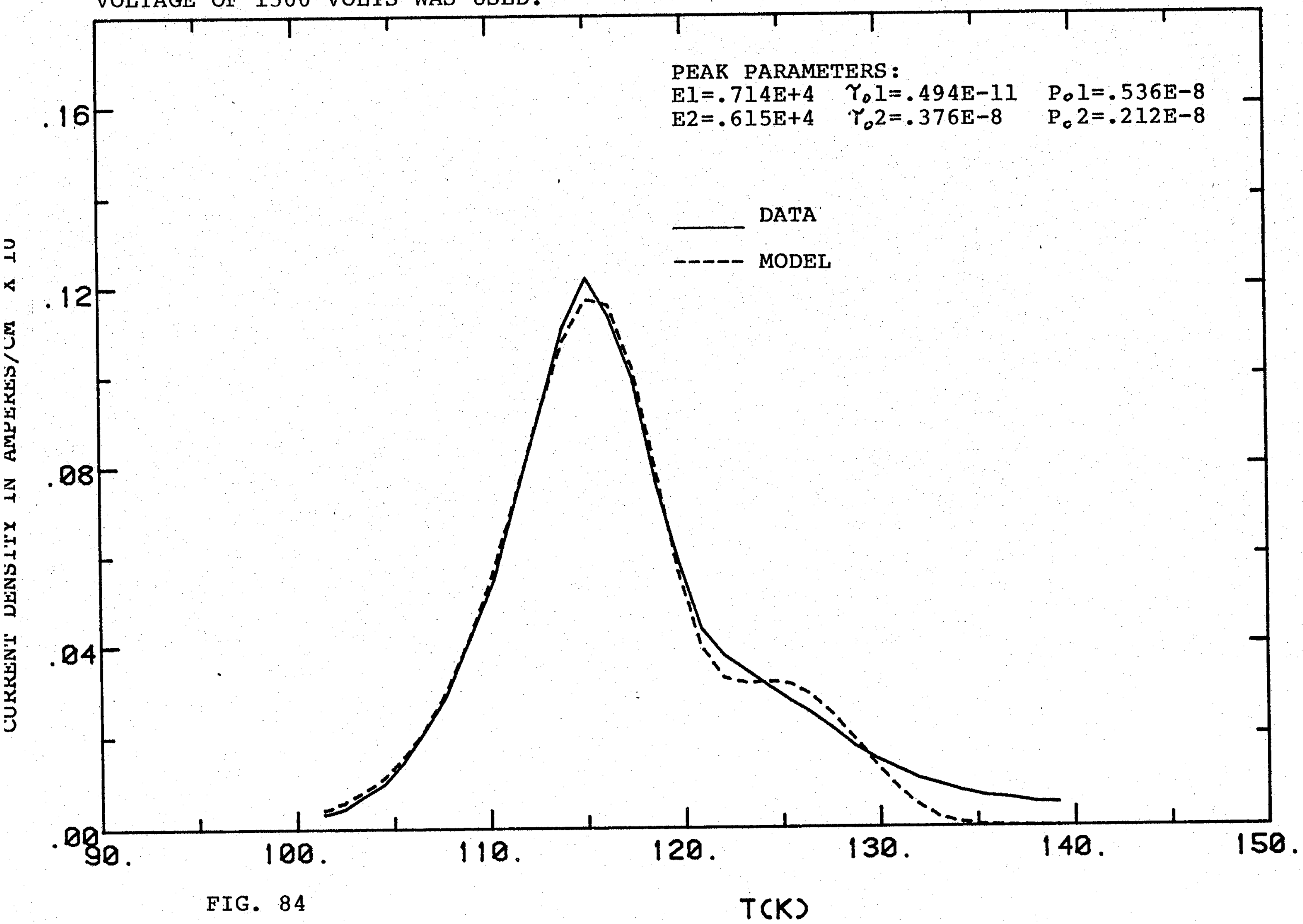


FIG. 84

A COMPARISON OF THE TSD DATA AND MODEL RESULTS OF THE THIRD REFREEZE OF SAMPLE # RTF6, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER AN 11 PSI VACUUM IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

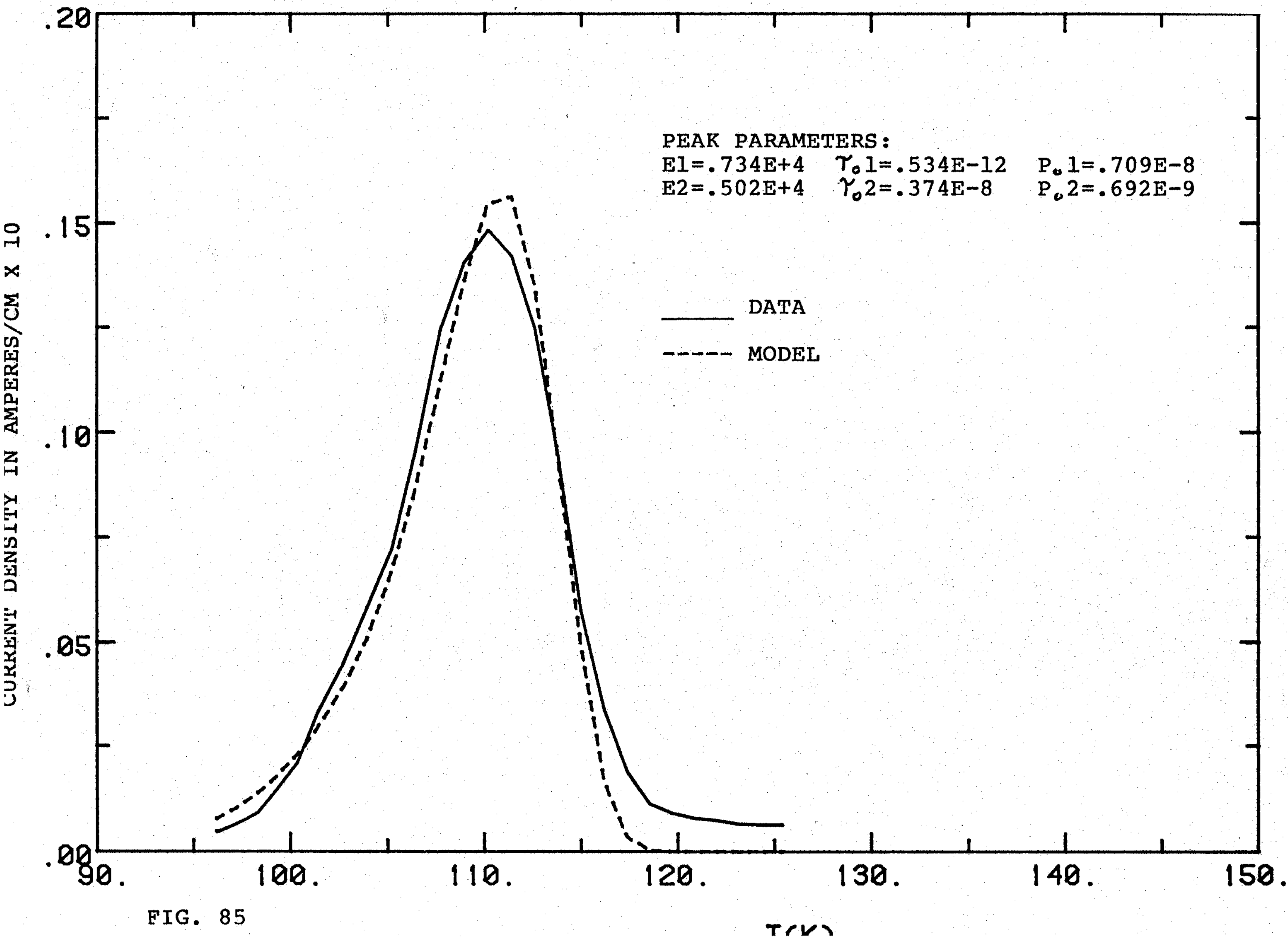


FIG. 85

A COMPARISON OF THE TSD DATA AND MODEL RESULTS OF THE FOURTH REFREEZE OF SAMPLE # RTF6, WHICH WAS FROZEN WITH TEFLON BLOCKING LAYERS UNDER CARBON DIOXIDE IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER. A HEATING RATE OF .019 DEG.K/SEC AND A CHARGING VOLTAGE OF 1500 VOLTS WAS USED.

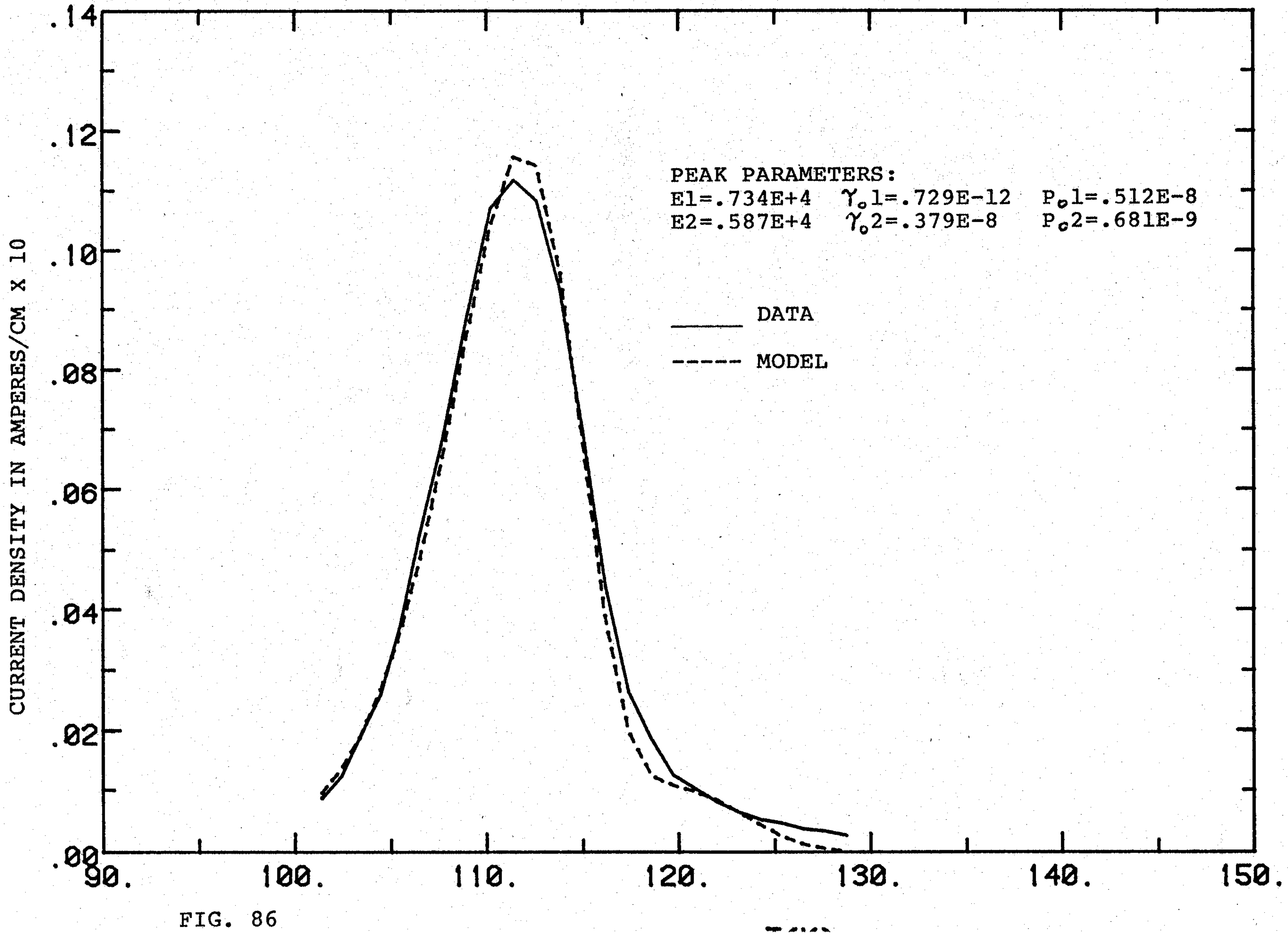


FIG. 86

APPENDIX VI-INVERSION PROGRAM MODELING PROCEDURE

THIS APPENDIX BRIEFLY DESCRIBES THE MATHEMATICS INVOLVED IN THE INVERSION MODELING PROGRAM. A MORE COMPLETE TREATMENT IS GIVEN IN WILL'S GREEN NOTEBOOK.

INVERSION PROGRAM MODELING PROCEDURE

The model equation that is used for this work is

$j(T)=(P_o/\gamma_o)\exp(-E/kT)\exp((-kT^2/q\gamma_o E)\exp(-E/kT)H(E/kT))$. This

can be represented as some function of the parameters E, γ_o, P

and the temperature as follows:

$y=f(E_1,E_2,....,E_n,\gamma_{o1},\gamma_{o2},....,\gamma_{on},P_{o1},P_{o2},....,P_{on},T)$.

Now let x_j be the model parameters (E,γ_o,P_o) where j=1,3(npeaks) and

let y_i be the data points (current densities) where i=1,ndata. So

$y_i=f_i(x_j,T_i)$, and now expand this function in a Taylor series about

some initial guess x_j^o. This gives the series equation

$y_i=f_i(x_j^o,T_i)+f_i'(x_j^o,T_i)(x_j-x_j^o)+<f_i''(x_j^o,T_i)(x_j-x_j^o)^2/2!+....>$.

The quantities in brackets are higher order derivative terms which

will be ignored, but will introduce some error. This Taylor series

expansion reduces to $y_i=f_i(x_j^o,T_i)+f_i'(x_j^o,T_i)(x_j-x_j^o)$+error.

Now for i=1 $\quad y_1-\sum_{j=1}^{k}f_1(x_j^o,T_1)=\sum_{j=1}^{k}f_1'(x_j^o,T_1)(x_j-x_j^o)$

for i=2 $\quad y_2-\sum_{j=1}^{k}f_2(x_j^o,T_2)=\sum_{j=1}^{k}f_2'(x_j^o,T_2)(x_j-x_j^o)$

⋮

for i=n $\quad y-\sum^{k}f(x^o,T)=\sum^{k}f'(x^o,T)(x-x^o)$

where n=ndata and k=3(npeaks). Solving this system of equations gives

$$\begin{Bmatrix} y_1-f_1 \\ y_2-f_2 \\ \vdots \\ y_n-f_n \end{Bmatrix} = \begin{bmatrix} \partial f_1/\partial x_1^o & \partial f_1/\partial x_2^o & \cdots\cdots & \partial f_1/\partial x_k^o \\ \partial f_2/\partial x_1^o & \partial f_2/\partial x_2^o & \cdots\cdots & \partial f_2/\partial x_k^o \\ \vdots & \vdots & & \vdots \\ \partial f_n/\partial x_1^o & \partial f_n/\partial x_2^o & \cdots\cdots & \partial f_n/\partial x_k^o \end{bmatrix} \begin{Bmatrix} x_1-x_1^o \\ x_2-x_2^o \\ \vdots \\ x_k-x_k^o \end{Bmatrix}$$

which can be simplified to $\langle\Delta Y\rangle=\langle A\rangle\langle\Delta X\rangle$, which can be transformed, by taking the inverse of the A matrix, to $\langle A\rangle^{-1}\langle\Delta Y\rangle=\langle\Delta X\rangle$. Since $x_j=x_j^o+x_j$, new parameters can be calculated from the equation $x_j=x_j^o+\langle A\rangle^{-1}\langle\Delta Y_i\rangle$. However, since the initial model equation is non-linear, an iteration scheme will be used with x_j as the new x_j^o.

To form the A matrix $\partial f/\partial E$, $\partial f/\partial\gamma_o$ and $\partial f/\partial P_o$ will need to be calculated. Now the partial derivatives are calculated as follows:

$$\partial j/\partial P_o=(1/\gamma_o)Z\exp((-kT^2/\gamma_o qE)ZH(E/kT))$$

$$\partial j/\partial\gamma_o=P_o Z\exp((-kT^2/\gamma_o qE)ZH(E/kT))((kT^2/\gamma_o^3 qE)ZH(E/kT)-1/\gamma_o^2)$$

$$\partial j/\partial E=P_o/\gamma_o Z\exp((-kT^2/qE\gamma_o)ZH(E/kT))((-kT^2/\gamma_o qE)Z(\partial H/\partial E-H/kT-H/E)-1/kT)$$

where Z=exp(-E/kT) and H(E/kT) is Hasting's approximation. To form

$$\partial H/\partial E=(b_1-a_1+(b_2-a_2)kT/E)(b_1kT/E^2+2b_2k^2T^2/E^3)/(1+b_1kT/E+b_2k^2T^2/E^2)^2$$
$$-(b_2-a_2)kT/E^2/(1+b_1kT/E+b_2k^2T^2/E^2).$$

The modeling procedure used weights the data and parameters according to their uncertainties. We have $\langle\Delta Y\rangle=\langle A\rangle\langle\Delta X\rangle$. If undata= standard deviation in data and unpar=standard deviation in parameters then $\langle\Delta Y\rangle/\mathrm{undata}=(\mathrm{unpar}/\mathrm{undata})\langle A\rangle\langle\Delta X\rangle/\mathrm{unpar}=\langle AW\rangle\langle\Delta X\rangle/\mathrm{unpar}$ where $\langle AW\rangle$ is the weighted A matrix. This gives an equation, for the change in parameters after each iteration, of $\langle\Delta X\rangle=(\mathrm{unpar}/\mathrm{undata})\langle AW\rangle^{-1}\langle\Delta Y\rangle$ and $\langle X_j\rangle=\langle\Delta X_j+X_j^o\rangle$ are the new parameters. The new uncertainties in the parameters are found by taking the square roots of the diagonal terms of $\langle\langle A\rangle^{-1}(\langle A\rangle^{-1})^T\rangle$ (T denotes matrix transpose) and multiplying by unpar, as is explained below. Remembering the equation $\langle\Delta X\rangle/\mathrm{unpar}=\langle AW\rangle^{-1}\langle\Delta Y\rangle/\mathrm{undata}$, and letting $B=\langle AW\rangle^{-1}$ gives $\langle\Delta X\rangle\langle\Delta X\rangle^T/\mathrm{unpar}^2=B(\langle\Delta Y\rangle\langle\Delta Y\rangle^T/\mathrm{undata}^2)B^T$. Now the covariance is calculated by $\mathrm{covariance}(\langle\Delta X\rangle\langle\Delta X\rangle^T)=(\mathrm{unpar}^2/\mathrm{undata}^2)BE(\langle\Delta Y\rangle\langle\Delta Y\rangle^T)B^T$ where E is the expectation. So $\mathrm{cov}(\langle\Delta X\rangle\langle\Delta X\rangle^T)=(\mathrm{unpar}^2/\mathrm{undata}^2)B(\mathrm{undata})^2B^T=\mathrm{unpar}^2BB^T$ which implies that $\langle\sigma_{\Delta X}\rangle=\mathrm{unpar}\langle\mathrm{diag}BB^T\rangle^{1/2}$ are the new uncertainties in the parameters.

A quantity that can help in making modeling decisions is big R if big $R<<1$ then the estimates for σ_i may be too large and or we have more parameters (too detailed a model) than are justified by the data.

if big $R>>1$ then the estimates for σ_i may be underestimated and or we may have too simplistic a model (not enough parameters).

if big $R\approx1$ then we probably have a reasonable solution, if the error estimates are correctly estimated.

The new parameter uncertainties, that are calculated, are not fed back into the iteration scheme as new uncertainties, but are kept in mind until the iterating is done. Then the parameter uncertainties give an idea of how well the inversion technique has determined each parameter (ie. the error involved in determining each parameter).

APPENDIX VII-SUBROUTINE DOCUMENTATION AND MODELING PROGRAM

THIS APPENDIX CONTAINS THE INVERSION MODELING PROGRAM SP.FOR USED TO MODEL ICE TSD DATA, DOCUMENTATION FOR THE IMSLIB SUBROUTINES THAT SP.FOR CALLS, AND AN EXAMPLE OF A PARAMETER FILE AND TEST RUN OF SP.FOR.

```
IMSL ROUTINE NAME   - LGINF

PURPOSE             - GENERALIZED INVERSE OF A REAL MATRIX

USAGE               - CALL LGINF (A,IA,M,N,TOL,AINV,IAINV,S,WK,IER)

ARGUMENTS    A      - M BY N MATRIX. (INPUT)  A IS DESTROYED.
             IA     - ROW DIMENSION OF MATRIX A EXACTLY AS
                        SPECIFIED IN THE DIMENSION STATEMENT IN THE
                        CALLING PROGRAM. (INPUT)
                        A IS USED BY LGINF AS WORK STORAGE FOR AN
                        N BY N MATRIX. THEREFORE, IA MUST BE
                        GREATER THAN OR EQUAL TO MAX(M,N).
             M      - NUMBER OF ROWS IN A. (INPUT)
             N      - NUMBER OF COLUMNS IN A. (INPUT)
             TOL    - TOLERANCE PARAMETER. (INPUT)
                        IF TOL IS LESS THAN OR EQUAL TO ZERO ON
                        INPUT, LGINF COMPUTES THE GENERALIZED
                        INVERSE OF A.
                        IF TOL IS GREATER THAN ZERO ON INPUT, LGINF
                        COMPUTES THE GENERALIZED INVERSE OF A MATRIX
                        CLOSE TO A, BUT HAVING CONDITION NUMBER LESS
                        THAN 1.0/TOL.
             AINV   - N BY M MATRIX. (OUTPUT)
                        AINV CONTAINS THE GENERALIZED INVERSE OF A
                        OR THE GENERALIZED INVERSE OF A MATRIX
                        CLOSE TO A. SEE TOL ARGUMENT DESCRIPTION.
             IAINV  - ROW DIMENSION OF MATRIX AINV EXACTLY AS
                        SPECIFIED IN THE DIMENSION STATEMENT IN THE
                        CALLING PROGRAM. (INPUT)
             S      - VECTOR OF LENGTH N. S CONTAINS THE ORDERED
                        SINGULAR VALUES OF A.  S(1) .GE. S(2),...,
                        .GE. S(N) .GE. 0. (OUTPUT)
             WK     - WORK VECTOR OF LENGTH 2N.
             IER    - ERROR PARAMETER. (OUTPUT)
                      WARNING ERROR
                        IER=33 INDICATES THAT MATRIX A IS NOT
                          FULL RANK OR VERY ILL-CONDITIONED. SMALL
                          SINGULAR VALUES MAY NOT BE VERY ACCURATE.
                        IER=34 INDICATES THAT EITHER N.LE.0 OR
                          M.LE.0.
                      TERMINAL ERROR
                        IER=129 INDICATES THAT CONVERGENCE WAS
                          NOT OBTAINED BY LSVDB AND COMPUTATION
                          WAS DISCONTINUED.

PRECISION/HARDWARE  - SINGLE AND DOUBLE/H32
                    - SINGLE/H36,H48,H60

REQD. IMSL ROUTINES - LGING,LSVDB,LSVG1,LSVG2,VHS12,UERSET,UERTST,
                        UGETIO

NOTATION            - INFORMATION ON SPECIAL NOTATION AND
                        CONVENTIONS IS AVAILABLE IN THE MANUAL
                        INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
```

Algorithm

LGINF calculates the generalized inverse of an M by N matrix A. Either M.GE.N or M.LT.N is permitted.

LGINF computes the singular value decomposition of A as follows:

$A = UQV^T$, where
U is an M by M orthogonal matrix,
Q is an M by N matrix with all elements zero except Q(I,I)=S(I), I=1,..., MIN (M,N), and
V is an N by N orthogonal matrix.

The pseudo-inverse is given by

$$A^+ = VQ^+U^T$$

See references:

1. Golub, G.H. and Reinsch, C., "Singular value decomposition and least squares solutions," Numerische Mathematik, 14(5), 1970, 403-42(

2. Lawson, Charles L. and Hanson, Richard J., Solving Least Squares Problems, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1974, 36-40.

Example

This example computes the generalized inverse of a 3 by 2 matrix A. The output generalized inverse is stored in AINV. The singular values are stored in vector S.

Input:

```
INTEGER   IA,M,N,IAINV,IER
REAL      A(3,2),TOL,AINV(2,3),S(2),WK(4)
```

$$A = \begin{bmatrix} 1. & 0. \\ 1. & 1. \\ 100. & -50. \end{bmatrix}$$

```
IA    =  3
IAINV =  2
M     =  3
N     =  2
TOL   = 0.0
CALL LGINF (A,IA,M,N,TOL,AINV,IAINV,S,WK,IER)
    .
    .
    .
END
```

Output:

IER = 0

$$AINV = \begin{bmatrix} .1 & .3 & .006 \\ .2 & .6 & -.008 \end{bmatrix}$$

S = (111.808,1.414)

IMSL ROUTINE NAME - VMULFF

PURPOSE - MATRIX MULTIPLICATION (FULL STORAGE MODE)

USAGE - CALL VMULFF (A,B,L,M,N,IA,IB,C,IC,IER)

ARGUMENTS

- A - L BY M MATRIX STORED IN FULL STORAGE MODE. (INPUT)
- B - M BY N MATRIX STORED IN FULL STORAGE MODE. (INPUT)
- L - NUMBER OF ROWS IN A. (INPUT)
- M - NUMBER OF COLUMNS IN A (SAME AS NUMBER OF ROWS IN B). (INPUT)
- N - NUMBER OF ~~ROWS~~ COLUMNS IN B. (INPUT)
- IA - ROW DIMENSION OF MATRIX A EXACTLY AS SPECIFIED IN THE DIMENSION STATEMENT IN THE CALLING PROGRAM. (INPUT)
- IB - ROW DIMENSION OF MATRIX B EXACTLY AS SPECIFIED IN THE DIMENSION STATEMENT IN THE CALLING PROGRAM. (INPUT)
- C - L BY N MATRIX CONTAINING THE PRODUCT C = A*B. (OUTPUT)
- IC - ROW DIMENSION OF MATRIX C EXACTLY AS SPECIFIED IN THE DIMENSION STATEMENT IN THE CALLING PROGRAM. (INPUT)
- IER - ERROR PARAMETER. (OUTPUT)
  TERMINAL ERROR
  IER=129 INDICATES A,B,OR C WAS DIMENSIONED INCORRECTLY.

PRECISION/HARDWARE - SINGLE AND DOUBLE/H32
- SINGLE/H36,H48,H60

REQD. IMSL ROUTINES - UERTST,UGETIO

NOTATION - INFORMATION ON SPECIAL NOTATION AND CONVENTIONS IS AVAILABLE IN THE MANUAL INTRODUCTION OR THROUGH IMSL ROUTINE UHELP

Algorithm

VMULFF performs the matrix multiplication A x B where both A and B are in full storage mode.

The following computation is performed:

$$C_{i,j} = \sum_{k=1}^{M} A_{i,k} B_{k,j},$$

where $i = 1,\ldots,L$ and $J = 1,\ldots,N$.

Example

This example multiplies a 4 by 5 matrix A by a 3 by 4 matrix B.

Input:

```
INTEGER  L,M,N,IA,IB,IC,IER
REAL     A(4,5),B(3,4),C(5,5)
```

$$A = \begin{bmatrix} 14. & 15. & 12. & x & x \\ 28. & -9. & -3. & x & x \\ 14. & -27. & 12. & x & x \\ 14. & 36. & 33. & x & x \end{bmatrix}$$

$$B = \begin{bmatrix} 1. & 2. & 1. & 1. \\ 2. & -1. & -2. & 5. \\ 3. & -1. & 1. & 8. \end{bmatrix}$$

L = 4
M = 3
N = 4
IA = 4
IB = 3
IC = 5

Output:

IER= 0

$$C = \begin{bmatrix} 80. & 1. & -4. & 185. & x \\ 1. & 68. & 43. & -41. & x \\ -4. & 43. & 80. & -25. & x \\ 185. & -41. & -25. & 458. & x \\ x & x & x & x & x \end{bmatrix}$$

x implies "not used by subroutine VMULFF".

To execute type EX‸ SP.FOR, SYS:IMSLIB/LIB

```
C        THIS IS PROGRAM SP.FOR THAT IS USED TO MODEL THE THERMALLY
C        STIMULATED DISCHARGE OF PURE ICE, WITH UP TO 5 PEAKS. IT
C        HAS ONE MODEL EQUATION:
C              J(T)=P/TAU*EXP(-E/(K*T))*EXP((-K*T**2/(Q*TAU*E)*
C                   EXP(-E/(K*T))*H)
C        WHERE J=DISCHARGE CURRENT DENSITY IN AMPS/CM**2
C              E=ACTIVATION ENERGY IN CAL/MOLE
C              TAU=RELAXATION PERIOD IN SEC
C              P=MAXIMUM POLARIZATION IN COUL/CM**2
C              T=ABSOLUTE TEMPERATURE
C              Q=HEATING RATE IN DEG C/SEC
C              K=BOLTZMAN CONSTANT   cal/°K-mole
C              H=NUMERICAL INTEGRAL  dimensionless
C        ANSWER QUESTIONS      1 YES       0 NO
C
C        THIS PROGRAM REQUIRES A DATA FILE, PARAMETER FILE; AND IT ASKS
C        FOR THE NUMBER OF PEAKS IN THE MODEL, UNCERTAINTY IN DATA,
C        TOLERANCE PARAMETER AND SAMPLE AREA.
C
C
C
         real descr(20),y0(100,1),emf(100),tc(100)
         1,tk(100),expn(100),dely(100,1),delx(15)
         1,a(100,15),aw(100,15),unpar(15)
         1,x(15),ainv(15,100),eva(15),wk(30)
         1,y2(100,1),y(100,1),uncerx(15),ainvt(100,15)
         1,er(15,15),diel(5),r(15,15),b(100,15)

         double precision datin,pdatin
         integer ndata,npeaks,npar,again,decide,index,ndec
         index=1

c        choose your input data file name
         write(5,1)
1        format(X,'INPUT DATA FILE NAME ?')
         read(5,2)datin
2        format(A10)

c        create disk files
         open(unit=20,access='seqin',file=datin)
         open(unit=23,access='seqout',file='pltout')

c        do you want data readout
         write(5,3)
3        format(X,'DO YOU WANT DATA READOUT')
         read(5,4)ndec
4        format(I)

c        read descriptive data from input data file
         do 5 i=1,3
         read(20,6)descr
6        format(20A5)
         if(ndec.EQ.0)go to 5

c        write out descriptive data
         write(5.7)descr
```

Input the current and thermocouple (emf) data file name. e.g. F152.dat

— Disk file for plotting modeling results

If answer is no then the is no computer printout and less display on video screen

Reads in data file name, sample #, data, freezing conditions etc.

```
c         read fourth line of data into input file
          read(20,8)ndata,dt,q
8         format(X,I3,X,f3.0,X,f5.3)
          if (ndec.EQ.0)go to 12

c         write out title to program
          write(3,11)
11        format(X,'THIS IS AN INVERSION PROGRAM FOR THE THERMALLY'
          1,/,X,'STIMULATED DISCHARGE OF ICE')

c         write out fourth line of data
          write(5,9)ndata,dt,q
9         format(/,X,'NUMBER OF DATA POINTS=',I3,/,X
          1,'INTERVAL BETWEEN DATA POINTS=',f3.0,'sec',/,X
          1,'HEATING RATE=',f5.3,'deg/sec',/)
          write(3,9)ndata,dt,q

c         write out headings
          write(5,10)
          write(3,10)
10        format(//,X,'CURRENT(A)',6X,'T COUPLE(MV)',4X,'CURR(E-10)'
          1,4X,'DEG C',4X,'DEG K',/)

c         read experimental data into input file
12        write(5,800)
800       format(X,'SAMPLE AREA IN CM**2 IN F FORMAT')
          read(5,801)sama
801       format(f)
          do 98 i=1,ndata
          read(20,13)y0(i,1),emf(i)
          y0(i,1)=y0(i,1)/sama
13        format(e,f)

c         call subroutine to convert thermocouple emfs to temperatures
          call convrt(emf(i),tc(i),tk(i))
          expn(i)=y0(i,1)/1.e-10
          if(ndec.EQ.0)go to 98

c         write out currents and temperatures
          write(5,14)y0(i,1),emf(i),expn(i),tc(i),tk(i)
          write(3,14)y0(i,1),emf(i),expn(i),tc(i),tk(i)
14        format(e,4X,f6.1,6X,f5.3,9X,f6.1,4X,f5.1)
98        continue

c         write out temperatures and data to pltout file
          do 16 i=1,ndata
          write(23,15)tk(i),expn(i)
15        format(2e)
16        continue

c         choose your parameter file name
          write(5,17)
17        format(X,'INITIAL PARAMETER FILE NAME ?')
          read(5,18)pdatin
18        format(A10)

c         create disk file
          open(unit=21,access='seqin',file=pdatin)

c         read the number of peaks in model
```

ndata = # of data point
dt = time interval bet data points
q = heating rate

sama — sample area e.g. 80.3 cm^2

read(20,13)… — read in current and emf data

y0(i,1)=y0(i,1)/sama — divide current by sample area to get a current density = j(T)

call convrt — convert thermocouple voltages temperatures

expn(i) — normalized current density data used for plotting

tc(i) — °C, tk(i) — °K

write out original current density vs. temperature data to plot file

Input the parameter filename e.g. p-dat

```
        if(ndec.EQ.0)go to 21
        write(3,22)npeaks
22      format(//,X,'NUMBER OF PEAKS IN MODEL=',I1)
21      npar=3*npeaks
```

— number of parameters = 3 times the number of peaks

```
c       read in the parameters and uncertainties
        do 23 i=1,npar
        read(21,24)x(i),uncerx(i)
        unpar(i)=uncerx(i)
24      format(e,e)
23      continue
```

The modeling program will calculate uncertainties in parameters which will be put in unpar(i)

read in E and σ_E, γ_0 and σ_{γ_0}, P_0 and σ_{P_0}

```
c       read uncertainty in data points
        write(5,25)
25      format(X,'UNCERTAINTY IN DATA ?')
        read(5,26)uncery
26      format(e)
        write(5,100)uncery
        if(ndec.EQ.0)go to 29
        write(3,100)uncery
100     format(/,X,'UNCERTAINTY IN DATA=',e)
```

uncery = estimated uncertainty in the current data e.g. 0.1×10^{-11}

```
c       write out parameters and their uncertainties
29      write(5,27)
        if(ndec.EQ.0)go to 28
        write(3,27)
27      format(////,X,'PARAMETERS',18X,'UNCERTAINTIES')
28      do 30 i=1,npeaks
        write(5,31)x(i),unpar(i)
        if(ndec.EQ.0)go to 30
        write(3,31)x(i),unpar(i)
31      format(X,'E=',e,10X,e)
30      continue
```

write out $E \pm \sigma_E$

```
        do 32 i=npeaks+1,2*npeaks
        write(5,33)x(i),unpar(i)
        if(ndec.EQ.0)go to 32
        write(3,33)x(i),unpar(i)
33      format(X,'TAU=',e,10X,e)
32      continue
```

write out $\gamma_0 \pm \sigma_{\gamma_0}$

```
        do 34 i=2*npeaks+1,3*npeaks
        write(5,35)x(i),unpar(i)
        if(ndec.EQ.0)go to 34
        write(3,35)x(i),unpar(i)
35      format(X,'P=',e,10X,e)
34      continue
```

write out $P_0 \pm \sigma_{P_0}$

```
c       intialize y(j,1) to 0.0
        do 39 j=1,ndata
        y(j,1)=0.0
39      continue
```

Initialize the new current densities (y-values) to 0.0

```
c       call subroutine to calculate H
        do 37 i=1,npeaks
        do 38 j=1,ndata
        call curint(tk(j),x(i),cinteg)
```

Subroutine to calculate H which is needed for the model equation

```
c       call subroutine to calculate new Y values from parameters and
c       model
        call ycalc(cinteg,tk(j),x(i),x(2*npeaks+i),x(npeaks+i)
     1,y2(j,1),q)
```

add y values together from each

```
c       find change in Y by subtracting new Y from old Y
        do 42 j=1,ndata
        dely(j,1)=y0(j,1)-y(j,1)
42      continue

c       write out new y and change in y
        if(ndec.EQ.0)go to 44
        write(3,43)
        write(5,43)
43      format(//,X,'NEW Y VALUES',6X,'CHANGE IN Y',9X,'TK')
        do 44 i=1,ndata
        write(5,45)y(i,1),dely(i,1),tk(i)
        write(3,45)y(i,1),dely(i,1),tk(i)
45      format(e,2X,e,2X,f)
44      continue

c       write out initial big R
        if(index.EQ.1)go to 47
        write(5,46)bigr
        if(ndec.EQ.0)go to 47
        write(3,46)bigr
46      format(/,X,'INITIAL BIG R =',X,e)

c       calculate big R
47      sum=0.0
        do 48 i=1,ndata
        sum=sum+(dely(i,1)/uncery)**2
48      continue
        xxt=ndata
        bigr=SQRT(sum/xxt)

c       weight dely
        do 101 i=1,ndata
        dely(i,1)=dely(i,1)/uncery
101     continue

c       write out big R
        write(5,49)bigr
        if(ndec.EQ.0)go to 50
        write(3,49)bigr
49      format(/,X,'BIG R=',X,e)

c       option to iterate
50      write(5,51)
51      format(X,'DO YOU WANT TO ITERATE ?')
        read(5,52)again
52      format(I)
        if(again.EQ.0)go to 53
        do 55 i=1,npeaks
        do 54 j=1,ndata

c       call subroutine to calculate H
        call curint(tk(j),x(i),cinteg)

c       call subroutine to calculate current derivative
        call acindr(tk(j),x(i),acint)

c       call subroutine to calculate A matrix
        call acalc(tk(j),x(i),x(npeaks+i),x(2*npeaks+i),a(j,i)
     1,a(i,npeaks+i),a(i,2*npeaks+i),cinteg,acint,g)
```

- find $\{\Delta y\}$
- write out initial big R only after 1st time through program
- big $R = \left[\frac{1}{ndata} \sum_{i=1}^{ndata} \left(\frac{\Delta y_i}{\text{uncertainty in data}} \right)^2 \right]^{1/2}$ — we would like big R ≤ 1
- weight $\{\Delta y\}$ matrix by the uncertainty in the data
- If big R < 1 then probably won't want to iterate
- calculate H needed for A matr
- calculates $\frac{\partial H}{\partial E}$ needed for $\frac{\partial j}{\partial E}$

```
c        write(5,56)
c        write(3,56)
56       format(//,X,'A MATRIX')
c        do 57 i=1,ndata
c        write(5,58)(a(i,j),j=1,npar)
c        write(3,58)(a(i,j),j=1,npar)
58       format(15e)
57       continue

c        weight A matrix according to parameter and data uncertainties
         do 59 i=1,npar
         do 60 j=1,ndata
         aw(j,i)=a(j,i)*uncerx(i)/uncery
60       continue
59       continue

c        write out weighted A matrix
c        write(5,61)
c        write(3,61)
61       format(//,X,'WEIGHTED A MATRIX')
c        do 62 i=1,ndata
c        write(5,58)(aw(i,j),j=1,npar)
c        write(3,58)(aw(i,j),j=1,npar)
62       continue

c        decide which eigenvalues are to be kept by setting tolerance
         write(5,63)
63       format(X,'TOLERANCE ?')
         read(5,64)tol
64       format(f)
         write(5,65)tol
         if(ndec.EQ.0)go to 66
         write(3,65)tol
65       format(/,X,'TOLERANCE= ',f)

c        create a dummy A matrix for LGINF
66       do 96 i=1,ndata
         do 97 j=1,npar
         b(i,j)=aw(i,j)
97       continue
96       continue

c        call subroutine to calculate generalized inverse
         call lginf(b,100,ndata,npar,tol,ainv,15,eva,wk,ier)

c        write out A inverse matrix
c        write(5,67)
c        write(3,67)
67       format(//,X,'A INVERSE MATRIX')
c        do 69 i=1,npar
c        write(5,68)(ainv(i,j),j=1,ndata)
c        write(3,68)(ainv(i,j),j=1,ndata)
68       format(45e)
69       continue

c        find the new XW values
         call vmulff(ainv,dely,npar,ndata,1,15,100,delx,15,ier)
         do 70 i=1,npar
         x(i)=delx(i)*uncerx(i)+x(i)
70       continue
```

weights [A] by multiplying $\left(\frac{\text{uncertainty in parameters}}{\text{uncertainty in data}}\right) \times [A] = [AW]$

Parameter needed for lginf subroutine. Usually we take tolerance = .01

Lginf subroutine will destroy [AW] matrix so feed it a duplicate matrix = [B]

Subroutine calculates $[AW]^{-1}$

subroutine VMULFF multiplies matrices together

$x = \Delta x + x_0$ (initial guess)

```
[AW] -->ainvt(i,j)=ainv(j,i)        the resulting matrix and multiplying by origina
72      continue                                                        uncertainty
71      continue
        call vmulff(ainv,ainvt,npar,ndata,npar,15,100,er,15,ier)
        do 73 i=1,npar
        unpar(i)=SQRT(er(i,i))*uncerx(i)
73      continue

c       write out er matrix        the er matrix = [AW]^-1 [AW]^-1 T
c       write(5,74)
c       write(3,74)
74      format(//,X,'THE AINV*AINVT MATRIX')
c       do 75 i=1,npar
c       write(5,76)(er(i,j),j=1,npar)
c       write(3,76)(er(i,j),j=1,npar)
76      format(15e)
75      continue

c       calculate the R matrix
        call vmulff(ainv,aw,npar,ndata,npar,15,100,r,15,ier)

c       write out R matrix          R matrix is a measure of uniqueness
c       write(5,77)                  of the solution. If R = identity matri
c       write(3,77)                   then there is a unique fit to data
77      format(//,X,'R MATRIX')
c       do 79 i=1,npar
c       write(5,78)(r(i,J),j=1,npar)
c       write(3,78)(r(i,j),j=1,npar)
78      format(15e)
79      continue

c       write out iteration heading
        if(ndec.EQ.0)go to 81
        write(3,80)
        write(5,80)
80      format(/,X,'AFTER ITERATING')
81      index=index+1 -- iteration counting index
        go to 29

c       write out final y values
53      if(ndec.EQ.0)go to 83
        write(5,82)
        write(3,82)
82      format(////,X,'CURRENT(A)',9X,'CURR(E-10)',5X,'DEG K')
83      do 84 i=1,ndata
        yfin=y(i,1)/1.E-10 -- normalize final y-values for plotting
        if(ndec.EQ.0)go to 84
        write(5,85)y(i,1),yfin,tk(i)   write out initial current density
        write(3,85)y(i,1),yfin,tk(i)   data, final current density calculated
85      format(X,e,6X,f5.3,8X,f5.1)    from parameters, and temperature
84      continue

c       option to create a plot file
        write(5,90)
90      format(X,'DO YOU WANT TO CREATE A PLOT FILE ?')
        read(5,91)decide
91      format(I)
        if(decide.EQ.0)go to 92
        do 93 i=1,ndata
        y(i,1)=y(i,1)/1.E-10          write out final y-values and
```

```
close(unit=21)
close(unit=23)
end

subroutine convrt(ee,tcc,tkk)
aa=-ee
a=2.383709e-02
b=-2.987839e-06
c=-7.194581e-10
d=-1.00419433e-13
tcc=a*aa+b*aa**2+c*aa**3+d*aa**4
tkk=273.2+tcc
return
end
```

°C °K Subroutine to convert thermocoup emfs to temperatures

```
subroutine curint(tkj,xwi,cinteg)
a1=2.334733
a2=0.250621
b1=3.330657
b2=1.681534
a=(1.98**2)*(tkj**2)/(xwi**2)
b=1.98*tkj/xwi
cinteg=(b1-a1+(b2-a2)*b)/(1.0+b1*b+b2*a)
return
end
```

°K E H calculates H needed for the model equation. H is Hasting's approximation to the current integral

```
subroutine ycalc(cinteg,tkj,xwi,xw2,xwn,yw2,q)
a=EXP(-xwi/(1.98*tkj))
b=-1.98*(tkj**2)/(q*xwi*xwn)
yw2=(xw2/xwn)*a*EXP(b*a*cinteg)
return
end
```

E's P_0's γ_0's calculates current densities from the model equation

```
subroutine acindr(tkj,xwi,acint)
a1=2.334733
a2=0.250621
b1=3.330657
b2=1.681534
a=1.98*tkj/xwi
b=a**2
c=b/xwi
d=a/xwi
e=1.0+b1*a+b2*b
f=b1-a1+(b2-a2)*a
f2=b1*d+2.0*b2*c
acint=(f/(e**2))*f2-((b2-a2)*d)/e
return
end
```

°K E $\frac{\partial H}{\partial E}$ calculates $\frac{\partial H}{\partial E}$ needed for $\frac{\partial j}{\partial E}$

```
subroutine acalc(tkj,xwi,xwn,xw2,aji,ajn,aj2,cinteg,acint,q)
a=EXP(-xwi/(1.98*tkj))
c=1.98*(tkj**2)/(q*xwi*xwn)
d=acint-(cinteg/(1.98*tkj))-cinteg/xwi
d2=c/(xwn**2)
aji=(xw2/xwn)*a*EXP(-c*a*cinteg)*(-c*a*d-1.0/(1.98*tkj))
ajn=xw2*a*EXP(-c*a*cinteg)*(a*cinteg*d2-1.0/(xwn**2))
aj2=(1.0/xwn)*a*EXP(-c*a*cinteg)
return
end
```

°K E γ_0 P_0 $\frac{\partial j}{\partial E}$ $\frac{\partial j}{\partial \gamma_0}$ $\frac{\partial j}{\partial P_0}$ H $\frac{\partial H}{\partial E}$

Calculates the elements needed for the

Example of a parameter file for a 3 peak spectrum

```
0.580E+4 0.1E+4
0.617E+4 0.1E+4
0.584E+4 0.1E+4
0.700E-9 0.1E-8
0.130E-8 0.1E-8
0.280E-6 0.1E-7
0.700E-8 0.1E-6
0.232E-8 0.1E-6
0.600E-8 0.1E-6
```

Lines 1–3: $E \pm \sigma_E$

Lines 4–6: $\gamma_0 \pm \sigma_{\gamma_0}$

Lines 7–9: $P_0 \pm \sigma_{P_0}$

SAMPLE # RSST7 RUN # F178 12/12/82
SAMPLE THICKNESS=0.375inches (83) PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI
THIS IS AN INVERSION PROGRAM FOR THE THERMALLY
STIMULATED DISCHARGE OF ICE

NUMBER OF DATA POINTS= 51
INTERVAL BETWEEN DATA POINTS=20.sec
HEATING RATE= .019deg/sec

TEST RUN FOR

SP. FOR

CURRENT(A)	T COUPLE(MV)	CURR(E-10)	DEG C	DEG K
0.8717310E-12	5135.0	.009	-173.6	99.6
0.1494396E-11	5105.0	.015	-172.0	101.2
0.2490660E-11	5070.0	.025	-170.2	103.0
0.3611457E-11	5047.0	.036	-169.1	104.1
0.5603985E-11	5020.0	.056	-167.7	105.5
0.6973848E-11	5004.0	.070	-166.9	106.3
0.9090909E-11	4980.0	.091	-165.7	107.5
0.1083437E-10	4960.0	.108	-164.7	108.5
0.1245330E-10	4940.0	.125	-163.7	109.5
0.1369863E-10	4920.0	.137	-162.8	110.4
0.1556663E-10	4895.0	.156	-161.5	111.7
0.1618929E-10	4880.0	.162	-160.8	112.4
0.1618929E-10	4850.0	.162	-159.4	113.8
0.1556663E-10	4820.0	.156	-157.9	115.3
0.1245330E-10	4790.0	.125	-156.5	116.7
0.1058531E-10	4774.0	.106	-155.8	117.4
0.8841843E-11	4745.0	.088	-154.4	118.8
0.6226650E-11	4720.0	.062	-153.3	119.9
0.4981320E-11	4700.0	.050	-152.3	120.9
0.4234122E-11	4680.0	.042	-151.4	121.8
0.3860523E-11	4650.0	.039	-150.1	123.1
0.3760897E-11	4620.0	.038	-148.7	124.5
0.3798257E-11	4600.0	.038	-147.8	125.4
0.3922790E-11	4580.0	.039	-146.9	126.3
0.4171856E-11	4550.0	.042	-145.6	127.6
0.4607721E-11	4520.0	.046	-144.3	128.9
0.5168120E-11	4500.0	.052	-143.4	129.8
0.5603985E-11	4480.0	.056	-142.5	130.7
0.6102117E-11	4450.0	.061	-141.2	132.0
0.6600249E-11	4425.0	.066	-140.1	133.1
0.7098381E-11	4405.0	.071	-139.3	133.9
0.7845579E-11	4380.0	.078	-138.2	135.0
0.8505604E-11	4350.0	.085	-137.0	136.2
0.8717310E-11	4330.0	.087	-136.1	137.1
0.8592777E-11	4300.0	.086	-134.9	138.3
0.8219178E-11	4280.0	.082	-134.0	139.2
0.7471980E-11	4256.0	.075	-133.1	140.1
0.6724782E-11	4224.0	.067	-131.7	141.5
0.5853051E-11	4200.0	.059	-130.8	142.4
0.4981320E-11	4180.0	.050	-130.0	143.2
0.4109589E-11	4140.0	.041	-128.3	144.9
0.3362391E-11	4115.0	.034	-127.3	145.9
0.2801993E-11	4090.0	.028	-126.4	146.8
0.2490660E-11	4060.0	.025	-125.2	148.0
0.2303861E-11	4030.0	.023	-124.0	149.2

0.2117061E-11	3975.0	.021	-121.8	151.4
0.1992528E-11	3900.0	.020	-119.0	154.2
0.1967621E-11	3835.0	.020	-116.5	156.7
0.1930262E-11	3790.0	.019	-114.8	158.4
0.1867995E-11	3705.0	.019	-111.7	161.5
0.1867995E-11	3650.0	.019	-109.6	163.6

NUMBER OF PEAKS IN MODEL=3

UNCERTAINTY IN DATA= 0.1000000E-11

PARAMETERS	UNCERTAINTIES
E= 0.5800000E+04	0.1000000E+04
E= 0.6170000E+04	0.1000000E+04
E= 0.5840000E+04	0.1000000E+04
TAU= 0.7000000E-09	0.1000000E-08
TAU= 0.1300000E-08	0.1000000E-08
TAU= 0.2800000E-06	0.1000000E-07
P= 0.7000000E-08	0.1000000E-06
P= 0.2320000E-08	0.1000000E-06
P= 0.6000000E-08	0.1000000E-06

NEW Y VALUES	CHANGE IN Y	TK
0.1673221E-11	-0.8014904E-12	99.6078033
0.2567071E-11	-0.1072675E-11	101.1607456
0.4068043E-11	-0.1577383E-11	102.9550705
0.5361075E-11	-0.1749618E-11	104.1241283
0.7178262E-11	-0.1574277E-11	105.4864616
0.8371975E-11	-0.1398127E-11	106.2887135
0.1021585E-10	-0.1124944E-11	107.4851131
0.1165478E-10	-0.8204106E-12	108.4757938
0.1281603E-10	-0.3627262E-12	109.4607887
0.1349879E-10	0.1998442E-12	110.4401588
0.1341643E-10	0.2150195E-11	111.6565552
0.1280659E-10	0.3382695E-11	112.3822708
0.1051111E-10	0.5678185E-11	113.8245430
0.7621366E-11	0.7945259E-11	115.2547665
0.5376629E-11	0.7076671E-11	116.6731415
0.4695724E-11	0.5889581E-11	117.4248333
0.4250955E-11	0.4590888E-11	118.7789211
0.4253305E-11	0.1973345E-11	119.9377098
0.4237414E-11	0.7439065E-12	120.8591328
0.4097862E-11	0.1362598E-12	121.7756329
0.3632316E-11	0.2282072E-12	123.1412773
0.2993550E-11	0.7673471E-12	124.4961624
0.2593473E-11	0.1204784E-11	125.3935280
0.2298516E-11	0.1624273E-11	126.2862473
0.2141732E-11	0.2030124E-11	127.6167316
0.2320443E-11	0.2287278E-11	128.9370632
0.2574495E-11	0.2593624E-11	129.8117313
0.2895587E-11	0.2708398E-11	130.6820183
0.3452214E-11	0.2649903E-11	131.9793491
0.3957500E-11	0.2642749E-11	133.0531425
0.4377041E-11	0.2721340E-11	133.9074612
0.4906287E-11	0.2939292E-11	134.9695473

```
 0.5520127E-11    0.2985476E-11     136.2356567
 0.5895658E-11    0.2821652E-11     137.0747204
 0.6369841E-11    0.2222936E-11     138.3259182
 0.6602515E-11    0.1616663E-11     139.1551971
 0.6767363E-11    0.7046175E-12     140.1452770
 0.6754513E-11   -0.2973088E-13     141.4569473
 0.6550526E-11   -0.6974754E-12     142.4344788
 0.6250498E-11   -0.1269178E-11     143.2450829
 0.5329660E-11   -0.1220071E-11     144.8555450
 0.4588581E-11   -0.1226190E-11     145.8549480
 0.3781608E-11   -0.9796156E-12     146.8489647
 0.2811080E-11   -0.3204201E-12     148.0347939
 0.1930814E-11    0.3730469E-12     149.2131443
 0.7628205E-12    0.1354241E-11     151.3545074
 0.1157203E-12    0.1876808E-11     154.2364101
 0.1075785E-13    0.1956864E-11     156.6999950
 0.1254146E-14    0.1929007E-11     158.3877888
 0.5241098E-17    0.1867990E-11     161.5379391
 0.4477231E-19    0.1867995E-11     163.5509701

 BIG R=    0.2600641E+01

 TOLERANCE=         0.0100000

 AFTER ITERATING

 PARAMETERS                          UNCERTAINTIES
 E=  0.5890843E+04                    0.1171692E+02
 E=  0.6062758E+04                    0.4126879E+02
 E=  0.5719206E+04                    0.1864958E+02
 TAU=  0.7289725E-09                    0.3270679E-11
 TAU=  0.1280608E-08                    0.7507166E-11
 TAU=  0.2799881E-06                    0.1815371E-11
 P=  0.7205809E-08                    0.2786058E-09
 P=  0.3601423E-08                    0.2866520E-09
 P=  0.7211128E-08                    0.2712942E-09

 NEW Y VALUES      CHANGE IN Y          TK
 0.1160844E-11   -0.2891128E-12      99.6078033
 0.1813426E-11   -0.3190296E-12     101.1607456
 0.2954682E-11   -0.4640217E-12     102.9550705
 0.3988456E-11   -0.3769995E-12     104.1241283
 0.5538479E-11    0.6550581E-13     105.4864616
 0.6636329E-11    0.3375189E-12     106.2887135
 0.8515018E-11    0.5758911E-12     107.4851131
 0.1024190E-10    0.5924699E-12     108.4757938
 0.1202236E-10    0.4309377E-12     109.4607887
 0.1372083E-10   -0.2219850E-13     110.4401588
 0.1545634E-10    0.1102870E-12     111.6565552
 0.1614267E-10    0.4662199E-13     112.3822708
 0.1638935E-10   -0.2000637E-12     113.8245430
 0.1500019E-10    0.5664315E-12     115.2547665
 0.1243956E-10    0.1374432E-13     116.6731415
 0.1092937E-10   -0.3440669E-12     117.4248333
 0.8489116E-11    0.3527271E-12     118.7789211
 0.6890942E-11   -0.6642920E-12     119.9377098
```

```
 0.5871981E-11    -0.8906610E-12       120.8591328
 0.4974990E-11    -0.7408684E-12       121.7756329
 0.3815807E-11     0.4471651E-13       123.1412773
 0.3059217E-11     0.7016792E-12       124.4961624
 0.2870126E-11     0.9281307E-12       125.3935280
 0.2926127E-11     0.9966630E-12       126.2862473
 0.3347896E-11     0.8239600E-12       127.6167316
 0.3996623E-11     0.6110978E-12       128.9370632
 0.4490762E-11     0.6773572E-12       129.8117313
 0.5011666E-11     0.5923193E-12       130.6820183
 0.5815452E-11     0.2866651E-12       131.9793491
 0.6476420E-11     0.1238295E-12       133.0531425
 0.6975912E-11     0.1224687E-12       133.9074612
 0.7531053E-11     0.3145260E-12       134.9695473
 0.8039000E-11     0.4666038E-12       136.2356567
 0.8246877E-11     0.4704328E-12       137.0747204
 0.8312756E-11     0.2800209E-12       138.3259182
 0.8171618E-11     0.4756026E-13       139.1551971
 0.7796686E-11    -0.3247059E-12       140.1452770
 0.6964959E-11    -0.2401765E-12       141.4569473
 0.6134647E-11    -0.2815956E-12       142.4344788
 0.5350626E-11    -0.3693060E-12       143.2450829
 0.3700076E-11     0.4095128E-12       144.8555450
 0.2731599E-11     0.6307922E-12       145.8549480
 0.1892280E-11     0.9097121E-12       146.8489647
 0.1108921E-11     0.1381739E-11       148.0347939
 0.5792437E-12     0.1724617E-11       149.2131443
 0.1242513E-12     0.1992810E-11       151.3545074
 0.6204185E-14     0.1986324E-11       154.2364101
 0.1584526E-15     0.1967463E-11       156.6999950
 0.6054816E-17     0.1930255E-11       158.3877888
 0.1669633E-20     0.1867995E-11       161.5379391
 0.1464367E-23     0.1867995E-11       163.5509701

INITIAL BIG R =    0.2600641E+01

BIG R=   0.8634365E+00

TOLERANCE=        0.0100000

AFTER ITERATING


PARAMETERS                      UNCERTAINTIES
E=   0.5905464E+04               0.2113834E+02
E=   0.6091063E+04               0.4951115E+02
E=   0.5717679E+04               0.1468552E+02
TAU=  0.7323521E-09                0.5044706E-11
TAU=  0.1285897E-08                0.9221577E-11
TAU=  0.2799881E-06                0.1451344E-11
P=   0.8033524E-08               0.9008278E-09
P=   0.2774572E-08               0.8783511E-09
P=   0.7515949E-08               0.2670421E-09

NEW Y VALUES       CHANGE IN Y            TK
 0.1152714E-11    -0.2809825E-12        99.6078033
 0.1803252E-11    -0.3088564E-12       101.1607456
```

0.2944069E-11	-0.4534087E-12	102.9550705
0.3980730E-11	-0.3692729E-12	104.1241283
0.5541005E-11	0.6298038E-13	105.4864616
0.6650633E-11	0.3232147E-12	106.2887135
0.8559034E-11	0.5318751E-12	107.4851131
0.1032540E-10	0.5089747E-12	108.4757938
0.1216153E-10	0.2917738E-12	109.4607887
0.1393190E-10	-0.2332656E-12	110.4401588
0.1577156E-10	-0.2049378E-12	111.6565552
0.1651763E-10	-0.3283350E-12	112.3822708
0.1682911E-10	-0.6398152E-12	113.8245430
0.1534651E-10	0.2201156E-12	115.2547665
0.1248363E-10	-0.3032579E-13	116.6731415
0.1075738E-10	-0.1720780E-12	117.4248333
0.7976937E-11	0.8649062E-12	118.7789211
0.6288513E-11	-0.6186306E-13	119.9377098
0.5368635E-11	-0.3873147E-12	120.8591328
0.4672987E-11	-0.4388650E-12	121.7756329
0.3832165E-11	0.2835818E-13	123.1412773
0.3250554E-11	0.5103429E-12	124.4961624
0.3089686E-11	0.7085703E-12	125.3935280
0.3136110E-11	0.7866798E-12	126.2862473
0.3536657E-11	0.6351990E-12	127.6167316
0.4192253E-11	0.4154680E-12	128.9370632
0.4703779E-11	0.4643405E-12	129.8117313
0.5246428E-11	0.3575573E-12	130.6820183
0.6084705E-11	0.1741174E-13	131.9793491
0.6773214E-11	-0.1729648E-12	133.0531425
0.7292612E-11	-0.1942305E-12	133.9074612
0.7868380E-11	-0.2280110E-13	134.9695473
0.8392234E-11	0.1133700E-12	136.2356567
0.8603868E-11	0.1134425E-12	137.0747204
0.8663265E-11	-0.7048767E-13	138.3259182
0.8509174E-11	-0.2899958E-12	139.1551971
0.8109735E-11	-0.6377548E-12	140.1452770
0.7232159E-11	-0.5073770E-12	141.4569473
0.6360493E-11	-0.5074421E-12	142.4344788
0.5539889E-11	-0.5585689E-12	143.2450829
0.3818550E-11	0.2910392E-12	144.8555450
0.2812367E-11	0.5500244E-12	145.8549480
0.1943009E-11	0.8589838E-12	146.8489647
0.1134477E-11	0.1356183E-11	148.0347939
0.5900962E-12	0.1713764E-11	149.2131443
0.1253947E-12	0.1991666E-11	151.3545074
0.6155371E-14	0.1986373E-11	154.2364101
0.1541268E-15	0.1967467E-11	156.6999950
0.5790046E-17	0.1930256E-11	158.3877888
0.1531854E-20	0.1867995E-11	161.5379391
0.1297854E-23	0.1867995E-11	163.5509701

INITIAL BIG R = 0.8634365E+00

BIG R= 0.8301531E+00

TOLERANCE= 0.0100000

AFTER ITERATING

PARAMETERS	UNCERTAINTIES
E= 0.5908797E+04	0.1778495E+02
E= 0.6115487E+04	0.6011468E+02
E= 0.5718426E+04	0.1415629E+02
TAU= 0.7325390E-09	0.3787434E-11
TAU= 0.1290431E-08	0.1116746E-10
TAU= 0.2799883E-06	0.1458857E-11
P= 0.8234123E-08	0.7912936E-09
P= 0.2599753E-08	0.7674756E-09
P= 0.7503277E-08	0.2677085E-09

NEW Y VALUES	CHANGE IN Y	TK
0.1146615E-11	-0.2748837E-12	99.6078033
0.1794229E-11	-0.2998327E-12	101.1607456
0.2930498E-11	-0.4398384E-12	102.9550705
0.3963611E-11	-0.3521542E-12	104.1241283
0.5519554E-11	0.8443056E-13	105.4864616
0.6626849E-11	0.3469987E-12	106.2887135
0.8532761E-11	0.5581483E-12	107.4851131
0.1029868E-10	0.5356886E-12	108.4757938
0.1213652E-10	0.3167801E-12	109.4607887
0.1391104E-10	-0.2124123E-12	110.4401588
0.1575848E-10	-0.1918541E-12	111.6565552
0.1650916E-10	-0.3198678E-12	112.3822708
0.1682255E-10	-0.6332628E-12	113.8245430
0.1531969E-10	0.2469359E-12	115.2547665
0.1241103E-10	0.4226567E-13	116.6731415
0.1065877E-10	-0.7346109E-13	117.4248333
0.7862410E-11	0.9794334E-12	118.7789211
0.6222807E-11	0.3842629E-14	119.9377098
0.5384593E-11	-0.4032734E-12	120.8591328
0.4786592E-11	-0.5524700E-12	121.7756329
0.4056069E-11	-0.1955461E-12	123.1412773
0.3483035E-11	0.2778620E-12	124.4961624
0.3275967E-11	0.5222891E-12	125.3935280
0.3258427E-11	0.6643630E-12	126.2862473
0.3575663E-11	0.5961922E-12	127.6167316
0.4188646E-11	0.4190746E-12	128.9370632
0.4689213E-11	0.4789065E-12	129.8117313
0.5227393E-11	0.3765925E-12	130.6820183
0.6063053E-11	0.3906391E-13	131.9793491
0.6750548E-11	-0.1502986E-12	133.0531425
0.7269662E-11	-0.1712811E-12	133.9074612
0.7845854E-11	-0.2746284E-15	134.9695473
0.8371552E-11	0.1340523E-12	136.2356567
0.8585292E-11	0.1320182E-12	137.0747204
0.8649124E-11	-0.5634664E-13	138.3259182
0.8498709E-11	-0.2795308E-12	139.1551971
0.8104174E-11	-0.6321943E-12	140.1452770
0.7233297E-11	-0.5085149E-12	141.4569473
0.6366148E-11	-0.5130966E-12	142.4344788
0.5548599E-11	-0.5672787E-12	143.2450829
0.3830638E-11	0.2789511E-12	144.8555450
0.2824559E-11	0.5378317E-12	145.8549480
0.1954002E-11	0.8479910E-12	146.8489647
0.1142949E-11	0.1347711E-11	148.0347939
0.5957340E-12	0.1708126E-11	149.2131443
0.1271775E-12	0.1989884E-11	151.3545074

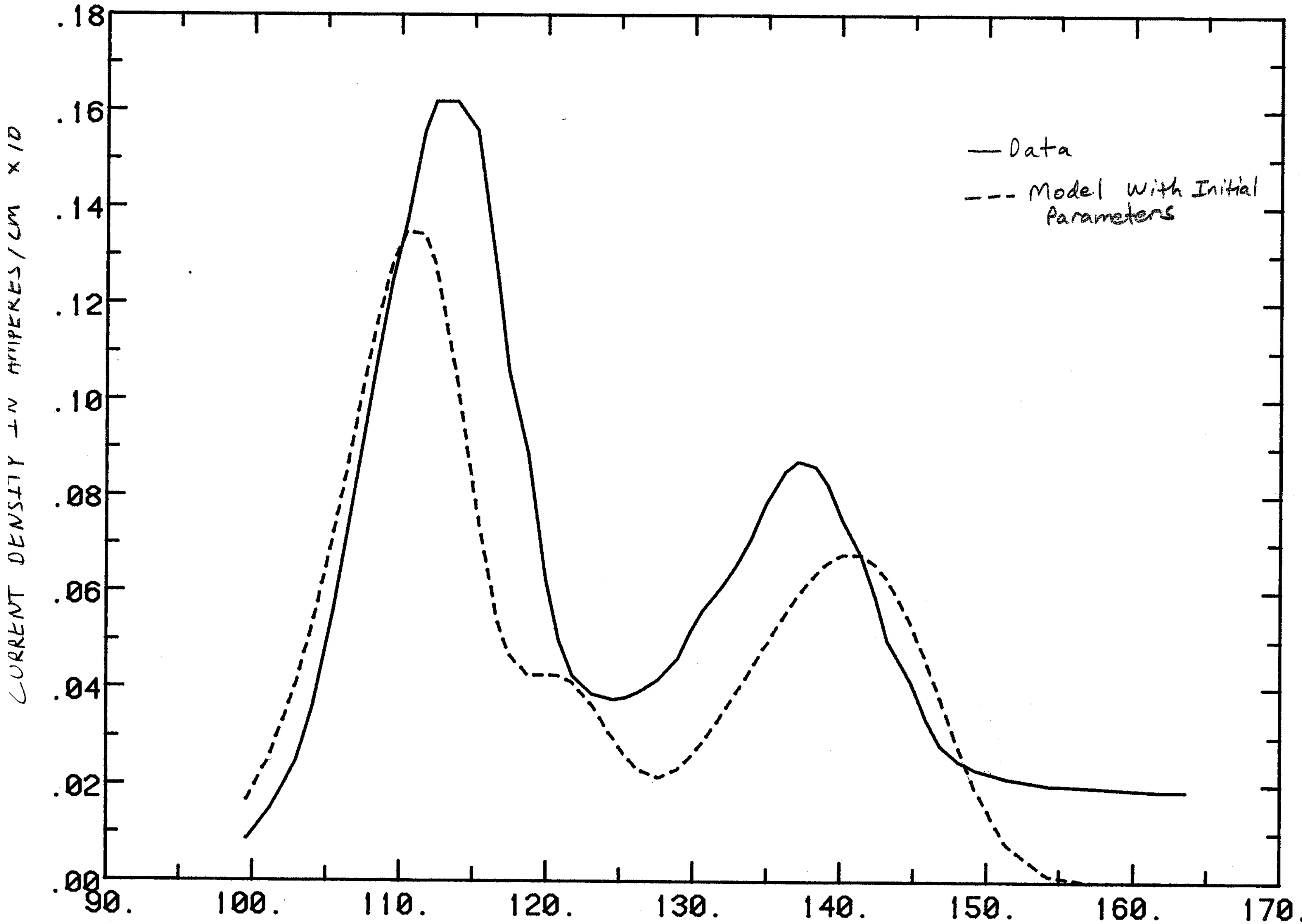
0.6295286E-14	0.1986233E-11	154.2364101
0.1591655E-15	0.1967462E-11	156.6999950
0.6029458E-17	0.1930256E-11	158.3877888
0.1627892E-20	0.1867995E-11	161.5379391
0.1402799E-23	0.1867995E-11	163.5509701

INITIAL BIG R = 0.8301531E+00

BIG R= 0.8264712E+00

CURRENT(A)	CURR(E-10)	DEG K
0.1146615E-11	.011	99.6
0.1794229E-11	.018	101.2
0.2930498E-11	.029	103.0
0.3963611E-11	.040	104.1
0.5519554E-11	.055	105.5
0.6626849E-11	.066	106.3
0.8532761E-11	.085	107.5
0.1029868E-10	.103	108.5
0.1213652E-10	.121	109.5
0.1391104E-10	.139	110.4
0.1575848E-10	.158	111.7
0.1650916E-10	.165	112.4
0.1682255E-10	.168	113.8
0.1531969E-10	.153	115.3
0.1241103E-10	.124	116.7
0.1065877E-10	.107	117.4
0.7862410E-11	.079	118.8
0.6222807E-11	.062	119.9
0.5384593E-11	.054	120.9
0.4786592E-11	.048	121.8
0.4056069E-11	.041	123.1
0.3483035E-11	.035	124.5
0.3275967E-11	.033	125.4
0.3258427E-11	.033	126.3
0.3575663E-11	.036	127.6
0.4188646E-11	.042	128.9
0.4689213E-11	.047	129.8
0.5227393E-11	.052	130.7
0.6063053E-11	.061	132.0
0.6750548E-11	.068	133.1
0.7269662E-11	.073	133.9
0.7845854E-11	.078	135.0
0.8371552E-11	.084	136.2
0.8585292E-11	.086	137.1
0.8649124E-11	.086	138.3
0.8498709E-11	.085	139.2
0.8104174E-11	.081	140.1
0.7233297E-11	.072	141.5
0.6366148E-11	.064	142.4
0.5548599E-11	.055	143.2
0.3830638E-11	.038	144.9
0.2824559E-11	.028	145.9
0.1954002E-11	.020	146.8
0.1142949E-11	.011	148.0
0.5957340E-12	.006	149.2
0.1271775E-12	.001	151.4

0.6295286E-14	.000	154.2
0.1591655E-15	.000	156.7
0.6029458E-17	.000	158.4
0.1627892E-20	.000	161.5
0.1402799E-23	.000	163.6



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.08
.06
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90.
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130.
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150.
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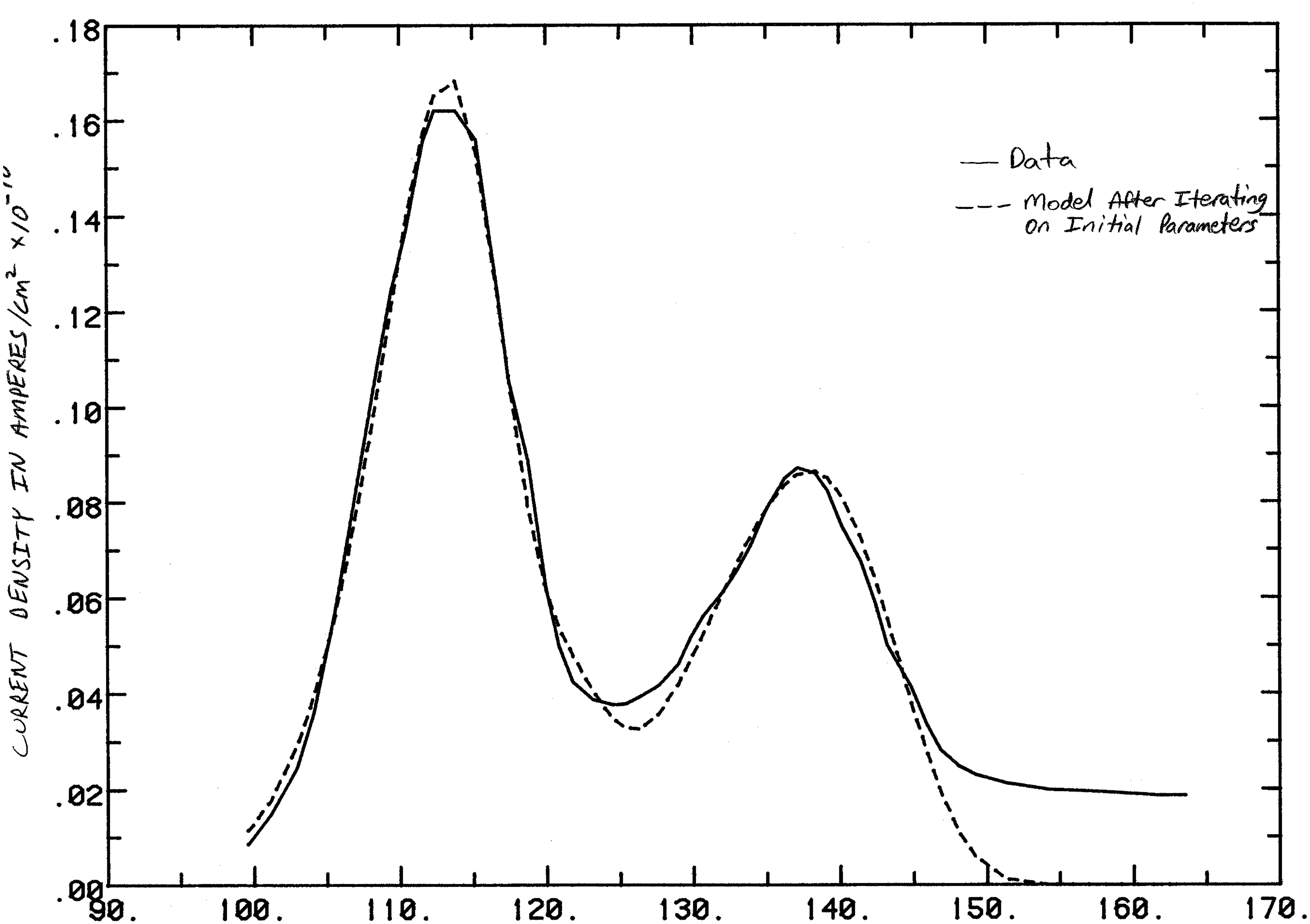
CURRENT DENSITY IN AMPERES/CM x10
— Data
--- Model With Initial Parameters



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90.
100.
110.
120.
130.
140.
150.
160.
170.
CURRENT DENSITY IN AMPERES/cm² ×10⁻¹⁰
— Data
--- Model After Iterating on Initial Parameters

APPENDIX VIII-INTEGRATING PROGRAM AND TSD DATA

THIS APPENDIX CONTAINS THE PROGRAM EASY.FOR THAT PRINTS OUT TSD DATA TO A PLOT FILE, AND INTEGRATES THE AREA UNDER THE TSD PLOT TO PRINT OUT THE CUMULATIVE CHARGE DENSITY TO THE PLOT FILE. ALSO LISTED IN THIS APPENDIX ARE PRINTOUTS OF THE TSD DATA USED IN THIS STUDY.

```
C       THIS IS PROGRAM EASY.FOR THAT IS USED TO INTEGRATE THE AREA UNDER
C       TSD PLOTS AND CALCULATE THE CUMULATIVE CHARGE RELEASED BY A TSD
C       RUN. IT ALSO WRITES THE TSD DATA STRAIGHT OUT TO A PLOT FILE ALONG
C       WITH THE CUMULATIVE DATA.
C
C       TO ANSWER QUESTIONS TYPE      1 YES      0 NO
C
C       THIS PROGRAM REQUIRES ANY DATA FILES THAT NEED TO BE WRITTEN OUT TO
C       A PLOT FILE AND THE SAMPLE AREA FOR EACH DATA FILE.
C
C
C
        real time(100),cod(100),charge(100)
        real y0(100,1),emf(100),tc(100),tk(100),expn(100),descr(20)
        double precision datin
        integer ndata


c       create disk files for plotter
        open(unit=22,access='seqout',file='chgout')
        open(unit=23,access='seqout',file='pltout')

c       choose your input data file name
902     write(5,1)
1       format(X,'INPUT DATA FILE NAME ?')
        read(5,2)datin
2       format(A10)

c       create disk files
        open(unit=20,access='seqin',file=datin)

c       read descriptive data from input data file
        do 5 i=1,3
        read(20,6)descr
6       format(20A5)
5       continue

c       read fourth line of data from input data file
        read(20,8)ndata,dt,q
8       format(X,I3,X,f3.0,X,f5.3)

c       read in TSD data from data file
        write(5,800)
800     format(X,'SAMPLE AREA IN CM**2 IN F FORMAT')
        read(5,801)sama
801     format(f)
        do 98 i=1,ndata
        read(20,13)y0(i,1),emf(i),time(i)
        y0(i,1)=y0(i,1)/sama
        cod(i)=y0(i,1)
13      format(e,f,f)

c       call subroutine to convert thermocouple voltages to temperatures
        call convrt(emf(i),tc(i),tk(i))
        expn(i)=y0(i,1)/1.E-10
98      continue

c       integrate the area under the TSD curve
        do 504 i=1,ndata
        charge(i)=0.0
```

```
504     continue
        cum=0.0
        charge(1)=(time(2)/2.0)*cod(1)
        do 500 i=2,(ndata-1)
        charge(i)=(time(i)/2.0+time(i+1)/2.0)*cod(i)
500     continue
        charge(ndata)=(time(ndata)/2.0)*cod(ndata)
        do 501 i=1,ndata
        cum=charge(i)+cum
        tum=cum*1.0E+8

c       write out cumulative charge released data to plot file
        write(22,502)tk(i),tum
502     format(2e)
501     continue

c       write out initial TSD data to plot file
        do 16 i=1,ndata
        write(23,15)tk(i),expn(i)
15      format(2e)
16      continue

c       do you have another curve to work on ?
        write(5,900)
900     format(X,'ANOTHER CURVE ?')
        read(5,901)ndec
901     format(I1)
        if(ndec.EQ.1)go to 902

        close(unit=20)
        close(unit=22)
        close(unit=23)
        end

        subroutine convrt(ee,tcc,tkk)
        aa=-ee
        a=2.383709E-2
        b=-2.987839E-6
        c=-7.194581E-10
        d=-1.00419433E-13
        tcc=a*aa+b*aa**2+c*aa**3+d*aa**4
        tkk=273.2+tcc
        return
        end
```

IN THE DATA FILES THAT FOLLOW THE FOLLOWING CODE IS USED TO REPRESENT THE SAMPLE NUMBER:

RSST1 (RADIAL SYMMETRY STAINLESS STEEL) MEANS THE FIRST SAMPLE FROZEN IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER WITHOUT TEFLON BLOCKING LAYERS

RTF1 (RADIAL TEFLON) MEANS THE FIRST SAMPLE FROZEN IN THE CONCENTRIC-CYLINDER SAMPLE HOLDER WITH TEFLON BLOCKING LAYERS

PIF/1 (PURE ICE FLAT) MEANS THE FIRST SAMPLE RUN IN THE FLAT-DISK SAMLE HOLDER.

LISTED BELOW ARE THE FIRST THREE LINES OF A DATA FILE:

```
  83 20. 0.019
0.49E-10 5140. 0.0
0.67E-10 5120. 60.
```

83=NUMBER OF DATA POINTS IN THE FILE, TO BE READ

20.=TIME INTERVAL IN SEC. BETWEEN DATA POINTS (NO LONGER USED IN MODELING PROGRAM BUT COULD BE USED IN INTEGRATING PROGRAM WHEN DIGITAL PRINTER IS USED)

0.019=HEATING RATE IN DEG.C/SEC

0.49E-10=TSD CURRENT IN AMPERES

5140.=THERMOCOUPLE EMF

0.0=TIME INTERVAL IN SEC. BETWEEN DATA POINTS (USED IN THE INTEGRATING PROGRAM)

SAMPLE # RSST1 RUN # F142 7/24/82
SAMPLE THICKNESS=0.375inches PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI
83 20. 0.019
0.49E-10 5140. 0.0
0.67E-10 5120. 60.
0.82E-10 5105. 60.
1.10E-10 5085. 60.
2.20E-10 5040. 120.
2.85E-10 5020. 60.
5.4E-10 4980. 120.
8.7E-10 4926. 120.
12.5E-10 4887. 120.
13.4E-10 4868. 60.
13.9E-10 4835. 60.
13.7E-10 4805. 60.
12.8E-10 4788. 60.
11.5E-10 4766. 60.
8.20E-10 4715. 120.
6.8E-10 4695. 60.
5.9E-10 4670. 60.
5.58E-10 4634. 60.
5.45E-10 4610. 60.
5.48E-10 4600. 60.
5.60E-10 4575. 60.
6.0E-10 4530. 60.
6.45E-10 4510. 60.
6.98E-10 4488. 60.
7.48E-10 4465. 60.
7.83E-10 4435. 60.
7.95E-10 4410. 60.
7.82E-10 4395. 60.
7.5E-10 4375. 60.
7.2E-10 4340. 60.
7.05E-10 4310. 60.
7.05E-10 4295. 60.
7.2E-10 4260. 60.
7.62E-10 4235. 60.
7.92E-10 4210. 60.
8.2E-10 4185. 60.
9.1E-10 4135. 120.
11.0E-10 4100. 60.
13.0E-10 4045. 120.
14.8E-10 4010. 60.
18.7E-10 3950. 120.
23.3E-10 3880. 120.
26.0E-10 3850. 60.
28.5E-10 3820. 60.
31.8E-10 3790. 60.
35.4E-10 3760. 60.
39.0E-10 3720. 60.
42.0E-10 3695. 60.
43.8E-10 3665. 60.
44.2E-10 3625. 60.
44.1E-10 3595. 60.
43.2E-10 3565. 60.
42.0E-10 3530. 60.
40.8E-10 3500. 60.
39.5E-10 3470. 60.
38.2E-10 3435. 60.
36.8E-10 3405. 60.
35.9E-10 3380. 60.
35.2E-10 3350. 60.
35.2E-10 3320. 60.

35.7E-10	3290.	60.
36.0E-10	3260.	60.
35.0E-10	3230.	60.
33.5E-10	3200.	60.
29.7E-10	3125.	120.
26.0E-10	3060.	120.
23.8E-10	3000.	120.
22.0E-10	2925.	120.
20.6E-10	2860.	120.
20.2E-10	2795.	120.
20.0E-10	2720.	120.
20.2E-10	2660.	120.
20.8E-10	2595.	120.
22.3E-10	2525.	120.
24.5E-10	2455.	120.
27.0E-10	2380.	120.
29.0E-10	2310.	120.
31.5E-10	2235.	120.
37.0E-10	2090.	240.
40.8E-10	2020.	120.
45.0E-10	1870.	240.
45.2E-10	1795.	120.
44.7E-10	1710.	120.

SAMPLE # RSST1 RUN # F143 7/27/82

SAMPLE THICKNESS=0.375inches (40) PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

83	20.	0.034
0.5E-10	5115.	0.0
0.6E-10	5100.	60.
1.4E-10	5062.	60.
2.5E-10	5035.	30.
3.2E-10	5020.	30.
4.3E-10	5000.	30.
6.0E-10	4985.	30.
8.3E-10	4970.	30.
10.0E-10	4949.	30.
15.5E-10	4915.	30.
17.0E-10	4907.	30.
21.8E-10	4880.	30.
24.5E-10	4865.	30.
28.5E-10	4825.	30.
29.2E-10	4810.	30.
29.1E-10	4795.	30.
27.0E-10	4774.	30.
23.5E-10	4745.	30.
21.0E-10	4730.	30.
16.0E-10	4710.	30.
13.5E-10	4695.	30.
11.2E-10	4675.	30.
9.0E-10	4650.	30.
8.2E-10	4626.	30.
7.7E-10	4600.	30.
7.3E-10	4550.	60.
7.65E-10	4505.	60.
8.1E-10	4480.	60.
8.8E-10	4430.	60.
9.1E-10	4390.	60.
9.4E-10	4335.	60.
9.5E-10	4290.	60.
9.7E-10	4245.	60.
10.0E-10	4200.	60.
10.8E-10	4150.	60.
12.0E-10	4100.	60.
14.0E-10	4050.	60.
17.0E-10	4000.	60.
21.0E-10	3948.	60.
28.0E-10	3890.	60.
36.0E-10	3830.	60.
43.0E-10	3780.	60.
50.5E-10	3710.	60.
53.5E-10	3675.	60.
55.4E-10	3600.	60.
54.5E-10	3550.	60.
49.2E-10	3500.	60.
46.1E-10	3425.	60.
45.2E-10	3380.	60.
43.7E-10	3300.	60.
41.8E-10	3265.	60.
39.5E-10	3200.	60.
37.7E-10	3150.	60.
35.2E-10	3100.	60.
33.5E-10	3050.	60.
31.5E-10	2990.	60.
29.8E-10	2920.	60.
28.1E-10	2880.	60.
26.2E-10	2760.	60.
26.1E-10	2700.	60.

26.8E-10	2630.	60.
27.8E-10	2580.	60.
29.0E-10	2505.	60.
30.8E-10	2450.	60.
32.4E-10	2385.	60.
34.2E-10	2325.	60.
36.2E-10	2265.	60.
38.9E-10	2200.	60.
41.7E-10	2145.	60.
44.2E-10	2070.	60.
48.0E-10	2000.	60.
51.3E-10	1940.	60.
54.0E-10	1875.	60.
55.2E-10	1800.	60.
56.0E-10	1735.	60.
56.1E-10	1710.	30.
56.3E-10	1680.	30.
56.7E-10	1647.	30.
56.8E-10	1610.	30.
57.0E-10	1575.	30.
57.1E-10	1540.	30.
57.2E-10	1500.	30
57.2E-10	1475.	30.

SAMPLE # RSSTI RUN # F144 7/30/82
SAMPLE THICKNESS=0.375inches (40) PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI

```
  83 20 0.009
0.15E-10 5205. 0.0
0.30E-10 5180. 240.
0.48E-10 5135. 120.
0.70E-10 5115. 120.
1.0E-10 5100. 120.
1.45E-10 5090. 120.
2.1E-10 5069. 120.
3.6E-10 5015. 240.
4.5E-10 4996. 120.
5.6E-10 4976. 120.
7.9E-10 4935. 240.
8.78E-10 4912. 120.
8.98E-10 4900. 60.
8.72E-10 4888. 60.
7.7E-10 4860. 120.
5.2E-10 4810. 240.
3.8E-10 4780. 120.
3.0E-10 4765. 120.
2.5E-10 4745. 120.
2.15E-10 4710. 120.
1.9E-10 4695. 120.
1.8E-10 4680. 120.
1.8E-10 4630. 120.
1.85E-10 4610. 120.
2.12E-10 4575. 240.
2.45E-10 4535. 120.
2.7E-10 4500. 240.
2.8E-10 4480. 120.
2.8E-10 4440. 120.
2.78E-10 4415. 120.
2.7E-10 4400. 120.
2.58E-10 4380. 120.
2.52E-10 4345. 120.
2.53E-10 4315. 120.
2.7E-10 4270. 240.
2.85E-10 4235. 120.
3.0E-10 4215. 120.
3.7E-10 4130. 360.
4.05E-10 4105. 120.
5.1E-10 4050. 120.
5.75E-10 4015. 120.
6.60E-10 3995. 120.
7.75E-10 3960. 120.
10.5E-10 3895. 240.
12.8E-10 3830. 240.
13.9E-10 3760. 240.
14.0E-10 3705. 240.
13.0E-10 3630. 240.
12.1E-10 3580. 240.
12.0E-10 3505. 240.
12.2E-10 3435. 240.
12.25E-10 3375. 240.
12.2E-10 3305. 240.
11.9E-10 3250. 240.
10.9E-10 3195. 240.
9.9E-10 3140. 240.
9.2E-10 3080. 240.
8.9E-10 3000. 240.
8.1E-10 2945. 240.
8.07E-10 2870. 240.
```

8.09E-10	2800.	240.
8.02E-10	2730.	240.
8.02E-10	2680.	240.
8.20E-10	2600.	240.
8.58E-10	2530.	240.
9.0E-10	2450.	240.
9.43E-10	2390.	240.
10.0E-10	2310.	240.
10.6E-10	2230.	240.
11.2E-10	2155.	240.
11.8E-10	2085.	240.
12.2E-10	2000.	240.
12.5E-10	1970.	120.
12.6E-10	1940.	120.
12.7E-10	1900.	120.
12.8E-10	1860.	120.
12.8E-10	1820.	120.
12.8E-10	1780.	120.
12.7E-10	1740.	120.
12.5E-10	1700.	120.
12.3E-10	1660.	120.
12.1E-10	1620.	120.
12.0E-10	1600.	60.

SAMPLE # RSSII RUN # P145 6/3/82

SAMPLE THICKNESS=0.375inches (40) PURE ICE VCH.=500

FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.032

0.13E-10	5170.	0.0
0.3E-10	5125.	60.
0.55E-10	5085.	60.
1.1E-10	5035.	60.
2.0E-10	5000.	60.
3.1E-10	4970.	60.
4.8E-10	4920.	60.
6.8E-10	4880.	60.
8.0E-10	4865.	30.
9.3E-10	4830.	30.
9.95E-10	4805.	30.
10.2E-10	4795.	30.
10.4E-10	4775.	30.
9.8E-10	4750.	30.
8.8E-10	4725.	30.
7.7E-10	4700.	30.
5.2E-10	4660.	60.
3.4E-10	4610.	60.
2.45E-10	4575.	60.
2.1E-10	4520.	60.
2.0E-10	4485.	60.
2.01E-10	4470.	30.
2.02E-10	4445.	30.
2.23E-10	4400.	60.
2.38E-10	4350.	60.
2.4E-10	4305.	60.
2.4E-10	4265.	60.
2.5E-10	4215.	60.
2.63E-10	4175.	60.
2.8E-10	4110.	60.
3.15E-10	4075.	60.
3.47E-10	4025.	60.
4.0E-10	3980.	60.
4.5E-10	3925.	60.
5.7E-10	3865.	60.
6.9E-10	3800.	60.
8.5E-10	3755.	60.
10.0E-10	3695.	60.
10.4E-10	3635.	60.
9.8E-10	3582.	60.
8.9E-10	3530.	60.
8.22E-10	3480.	60.
7.72E-10	3410.	60.
7.47E-10	3360.	60.
7.42E-10	3330.	30.
7.70E-10	3300.	30.
8.37E-10	3240.	60.
8.50E-10	3200.	60.
8.59E-10	3135.	60.
8.60E-10	3090.	60.
8.57E-10	3020.	60.
8.49E-10	2985.	60.
8.36E-10	2905.	60.
8.10E-10	2850.	60.
7.70E-10	2805.	60.
7.52E-10	2750.	60.
7.50E-10	2720.	30.
7.55E-10	2700.	30.
7.71E-10	2625.	60.
8.10E-10	2585.	60.

8.75E-10	2505.	60.
9.40E-10	2450.	60.
10.2E-10	2390.	60.
11.6E-10	2320.	60.
12.7E-10	2275.	60.
14.0E-10	2200.	60.
14.3E-10	2175.	30.
15.0E-10	2130.	30.
16.0E-10	2080.	60.
16.9E-10	2030.	30.
17.8E-10	2005.	30.
19.0E-10	1930.	60.
19.3E-10	1875.	60.
19.6E-10	1800.	60.
19.9E-10	1730.	60.
20.0E-10	1685.	60.
20.1E-10	1605.	60.
20.3E-10	1575.	30.
20.5E-10	1535.	30.
20.9E-10	1500.	30.
21.1E-10	1470.	30.
21.2E-10	1435.	30.
21.3E-10	1400.	30.

SAMPLE # RSST1 RUN # F146 8/5/82
SAMPLE THICKNES=0.375inches (40) PURE ICE VCH.=232
FROZEN UNDER A VACUUM OF 12 PSI

83	20.	0.032
0.0E-10	5180.	0.0
0.02E-10	5130.	60.
0.1E-10	5100.	60.
0.22E-10	5065.	60.
0.45E-10	5020.	60.
0.85E-10	4980.	60.
1.5E-10	4930.	60.
2.4E-10	4900.	60.
3.45E-10	4850.	60.
4.6E-10	4805.	60.
4.9E-10	4790.	30.
5.05E-10	4770.	30.
4.4E-10	4710.	60.
3.4E-10	4675.	60.
2.15E-10	4620.	60.
1.4E-10	4590.	60.
0.95E-10	4535.	60.
0.85E-10	4495.	60.
0.8E-10	4450.	60.
0.77E-10	4405.	60.
0.82E-10	4380.	60.
0.90E-10	4325.	60.
0.97E-10	4285.	60.
1.02E-10	4235.	60.
1.10E-10	4185.	60.
1.15E-10	4130.	60.
1.23E-10	4090.	60.
1.35E-10	4045.	60.
1.45E-10	4000.	60.
1.65E-10	3945.	60.
1.9E-10	3890.	60.
2.5E-10	3825.	60.
3.1E-10	3780.	60.
3.7E-10	3715.	60.
4.0E-10	3690.	30.
4.21E-10	3665.	30.
4.2E-10	3625.	30.
4.05E-10	3605.	30.
3.6E-10	3560.	60.
3.1E-10	3500.	60.
2.61E-10	3430.	60.
2.49E-10	3390.	60.
2.51E-10	3310.	60.
2.60E-10	3275.	60.
2.62E-10	3205.	60.
2.68E-10	3150.	60.
2.70E-10	3100.	60.
2.76E-10	3050.	60.
2.79E-10	3000.	60.
2.82E-10	2940.	60.
2.84E-10	2890.	60.
2.86E-10	2825.	60.
2.96E-10	2780.	60.
3.05E-10	2705.	60.
3.14E-10	2665.	60.
3.32E-10	2600.	60.
3.58E-10	2555.	60.
4.05E-10	2500.	60.
4.70E-10	2425.	60.
5.50E-10	2375.	60.

6.40E-10	2300.	60.
7.15E-10	2250.	60.
7.80E-10	2215.	30.
8.40E-10	2195.	30.
8.90E-10	2140.	30.
9.30E-10	2105.	30.
9.70E-10	2080.	30.
9.90E-10	2045.	30.
10.1E-10	2015.	30.
10.3E-10	1990.	30.
10.6E-10	1950.	30.
10.8E-10	1905.	30.
11.00E-10	1880.	30.
11.22E-10	1840.	30..
11.24E-10	1790.	60.
11.27E-10	1720.	60.
11.30E-10	1650.	60.
11.50E-10	1590.	60.
11.60E-10	1560.	30.
11.70E-10	1520.	30.
11.80E-10	1490.	30.
11.90E-10	1460.	30.
12.00E-10	1425.	30.

SAMPLE THICKNESS=0.375inches PURE ICE VCH.=500
FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019

0.34E-10	5080.	0.0
0.50E-10	5050.	60.
0.75E-10	5025.	60.
1.10E-10	5000.	60.
1.40E-10	4980.	60.
1.83E-10	4965.	60.
2.42E-10	4935.	60.
3.20E-10	4910.	60.
4.10E-10	4890.	60.
4.75E-10	4868.	60.
5.50E-10	4842.	60.
6.00E-10	4815.	60.
6.10E-10	4795.	60.
6.00E-10	4768.	60.
5.35E-10	4742.	60.
4.40E-10	4715.	60.
3.60E-10	4695.	60.
2.90E-10	4675.	60.
2.13E-10	4647.	60.
1.80E-10	4620.	60.
1.50E-10	4600.	60.
1.32E-10	4575.	60.
1.22E-10	4545.	60.
1.18E-10	4520.	60.
1.16E-10	4500.	60.
1.15E-10	4480.	60.
1.19E-10	4453.	60.
1.28E-10	4422.	60.
1.40E-10	4400.	60.
1.45E-10	4375.	60.
1.46E-10	4350.	60.
1.41E-10	4323.	60.
1.40E-10	4300.	60.
1.38E-10	4275.	60.
1.37E-10	4250.	60.
1.38E-10	4220.	60.
1.40E-10	4190.	60.
1.43E-10	4170.	60.
1.50E-10	4140.	60.
1.55E-10	4110.	60.
1.61E-10	4080.	60.
1.71E-10	4050.	60.
1.81E-10	4022.	60.
1.99E-10	3995.	60.
2.18E-10	3962.	60.
2.37E-10	3930.	60.
2.62E-10	3903.	60.
2.89E-10	3873.	60.
3.16E-10	3838.	60.
3.38E-10	3815.	60.
3.63E-10	3790.	60.
3.93E-10	3760.	60.
4.22E-10	3730.	60.
4.5E-10	3700.	60.
4.6E-10	3672.	60.
4.6E-10	3640.	60.
4.58E-10	3615.	60.
4.4E-10	3580.	60.
4.15E-10	3500.	120.
3.97E-10	3450.	120.

4.00E-10	3385.	120.
4.30E-10	3310.	120.
4.69E-10	3242.	120.
5.00E-10	3185.	120.
5.30E-10	3120.	120.
5.43E-10	3065.	120.
5.48E-10	3000.	120.
5.43E-10	2930.	120.
5.20E-10	2870.	120.
4.81E-10	2805.	120.
4.70E-10	2740.	120.
4.72E-10	2685.	120.
4.78E-10	2612.	120.
5.03E-10	2550.	120.
5.48E-10	2483.	120.
6.00E-10	2405.	120.
6.70E-10	2335.	120.
7.90E-10	2205.	240.
9.30E-10	2065.	240.
10.2E-10	1910.	240.
11.0E-10	1750.	240.
11.6E-10	1600.	240.
12.8E-10	1440.	240.

SAMPLE # RSST1 RUN # F148 8/16/82
SAMPLE THICKNESS=0.375inches (40) PURE ICE VCH.=500
FROZEN UNDER A VACUUM OF 12 PSI

```
  83 20. 0.009
0.0E-10 5180. 0.0
0.06E-10 5140. 120.
0.1E-10 5120. 120.
0.13E-10 5105. 120.
0.19E-10 5090. 120.
0.35E-10 5055. 120.
0.48E-10 5035. 120.
0.65E-10 5020. 120.
0.9E-10 5005. 120.
1.15E-10 4985. 120.
1.48E-10 4965. 120.
1.85E-10 4935. 120.
2.3E-10 4912. 120.
2.7E-10 4890. 120.
2.91E-10 4870. 120.
3.1E-10 4834. 120.
2.91E-10 4810. 120.
2.55E-10 4790. 120.
2.1E-10 4770. 120.
1.7E-10 4745. 120.
1.35E-10 4720. 120.
1.1E-10 4700. 120.
0.86E-10 4685. 120.
0.68E-10 4636. 120.
0.6E-10 4615. 120.
0.55E-10 4600. 120.
0.58E-10 4575. 120.
0.6E-10 4550. 120.
0.62E-10 4500. 120.
0.67E-10 4455. 360.
0.7E-10 4385. 180.
0.7E-10 4335. 360.
0.72E-10 4255. 360.
0.75E-10 4210. 180.
0.8E-10 4125. 360.
0.85E-10 4090. 180.
1.08E-10 3995. 360.
1.20E-10 3955. 180.
1.4E-10 3900. 180.
1.68E-10 3865. 180.
2.02E-10 3800. 240.
2.32E-10 3730. 240.
2.27E-10 3680. 240.
2.20E-10 3605. 240.
2.18E-10 3530. 240.
2.22E-10 3485. 240.
2.38E-10 3405. 240.
2.50E-10 3350. 240.
2.93E-10 3275. 240.
3.02E-10 3210. 240.
3.01E-10 3155. 240.
2.90E-10 3095. 240.
2.87E-10 3030. 240.
2.77E-10 2975. 240.
2.68E-10 2900. 240.
2.60E-10 2830. 240.
2.59E-10 2785. 240.
2.61E-10 2705. 240.
2.72E-10 2630. 240.
2.92E-10 2570. 240.
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3.13E-10	2500.	240.
3.46E-10	2420.	240.
3.65E-10	2390.	120.
3.75E-10	2365.	120.
3.88E-10	2330.	120.
4.02E-10	2290.	120.
4.20E-10	2250.	120.
4.38E-10	2205.	120.
4.70E-10	2130.	240.
4.90E-10	2090.	120.
5.08E-10	2050.	120.
5.21E-10	2020.	120.
5.35E-10	1980.	120.
5.48E-10	1940.	120.
5.52E-10	1920.	60.
5.55E-10	1900.	60.
5.60E-10	1885.	60.
5.63E-10	1870.	60.
5.67E-10	1853.	60.
5.69E-10	1830.	60.
5.72E-10	1810.	60.
5.74E-10	1790.	60.
5.78E-10	1770.	60.

SAMPLE # RSST1 RUN # F149 8/15/82

SAMPLE THICKNESS=0.375inches (40) PURE ICE VCH.=230

FROZEN UNDER A VACUUM OF 12 PSI

72	20.	0.009
0.0E-10	5135.	0.0
0.01E-10	5125.	120.
0.05E-10	5100.	120.
0.1E-10	5080.	120.
0.14E-10	5060.	120.
0.25E-10	5020.	120.
0.31E-10	5005.	120.
0.45E-10	4990.	120.
0.63E-10	4975.	120.
0.8E-10	4945.	120.
1.0E-10	4925.	120.
1.18E-10	4905.	120.
1.3E-10	4885.	120.
1.4E-10	4870.	120.
1.38E-10	4829.	120.
1.29E-10	4805.	120.
1.13E-10	4790.	120.
0.92E-10	4765.	120.
0.73E-10	4740.	120.
0.58E-10	4710.	120.
0.41E-10	4695.	120.
0.35E-10	4670.	120.
0.28E-10	4640.	120.
0.23E-10	4610.	120.
0.21E-10	4600.	120.
0.2E-10	4550.	180.
0.21E-10	4505.	180.
0.22E-10	4495.	180.
0.25E-10	4385.	180.
0.27E-10	4300.	180.
0.28E-10	4270.	180.
0.31E-10	4130.	180.
0.38E-10	4050.	180.
0.40E-10	4005.	180.
0.45E-10	3975.	180.
0.52E-10	3915.	180.
0.68E-10	3870.	180.
0.90E-10	3805.	180.
1.01E-10	3790.	180.
1.01E-10	3760.	180.
0.90E-10	3705.	180.
0.81E-10	3685.	180.
0.71E-10	3660.	180.
0.63E-10	3625.	180.
0.58E-10	3600.	120.
0.52E-10	3570.	120.
0.51E-10	3530.	120.
0.49E-10	3500.	120.
0.49E-10	3475.	120.
0.50E-10	3435.	120.
0.51E-10	3400.	120.
0.55E-10	3340.	120.
0.67E-10	3280.	120.
0.80E-10	3215.	120.
0.91E-10	3155.	120.
1.00E-10	3090.	120.
1.00E-10	3030.	120.
1.02E-10	2965.	240.
1.10E-10	2890.	240.
1.12E-10	2830.	240.

1.19E-10	2765.	240.
1.26E-10	2705.	240.
1.39E-10	2630.	240.
1.52E-10	2565.	240.
1.69E-10	2490.	240.
1.89E-10	2425.	240.
2.13E-10	2360.	240.
2.38E-10	2285.	240.
2.68E-10	2210.	240.
2.87E-10	2130.	240.
3.02E-10	2065.	240.
3.21E-10	1980.	240.

SAMPLE # RSST2 RUN # F151 8/26/82
SAMPLE THICKNESS=.375 in. PURE ICE VCH.=1900
FROZEN UNDER A VACUUM OF 12 PSI

49	20. 0.008
0.5E-10	5115.
0.8E-10	5075.
1.0E-10	5060.
1.3E-10	5030.
1.6E-10	5010.
1.9E-10	4995.
2.3E-10	4979.
2.6E-10	4962.
3.1E-10	4940.
3.6E-10	4915.
4.0E-10	4895.
4.5E-10	4870.
5.0E-10	4840.
5.3E-10	4820.
5.5E-10	4800.
5.5E-10	4790.
5.3E-10	4760.
5.0E-10	4738.
4.6E-10	4708.
4.2E-10	4672.
3.9E-10	4650.
3.7E-10	4615.
3.5E-10	4588.
3.3E-10	4560.
3.2E-10	4530.
3.3E-10	4510.
3.5E-10	4485.
3.7E-10	4465.
4.0E-10	4430.
4.4E-10	4395.
4.7E-10	4380.
4.9E-10	4350.
4.96E-10	4310.
4.9E-10	4300.
4.7E-10	4255.
4.4E-10	4200.
4.1E-10	4150.
3.95E-10	4100.
4.0E-10	4080.
4.3E-10	4020.
4.6E-10	3990.
4.9E-10	3945.
5.2E-10	3900.
5.5E-10	3850.
5.55E-10	3805.
5.5E-10	3790.
5.2E-10	3730.
5.0E-10	3705.
4.8E-10	3680.

SAMPLE # RTF1 RUN # F152 9/7/82
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
FROZEN UNDER A 12 PSI VACUUM

83	20.	0.019
0.43E-10	5120.	0.0
0.73E-10	5100.	60.
1.20E-10	5070.	60.
1.86E-10	5034.	60.
2.70E-10	5008.	60.
3.75E-10	4986.	60.
4.75E-10	4963.	60.
6.00E-10	4940.	60.
7.20E-10	4920.	60.
8.33E-10	4895.	60.
9.20E-10	4873.	60.
9.28E-10	4850.	60.
9.00E-10	4825.	60.
8.00E-10	4800.	60.
6.70E-10	4777.	60.
5.40E-10	4752.	60.
4.18E-10	4725.	60.
3.50E-10	4700.	60.
2.90E-10	4680.	60.
2.50E-10	4660.	60.
2.20E-10	4633.	60.
1.94E-10	4612.	60.
1.70E-10	4590.	60.
1.55E-10	4565.	60.
1.47E-10	4530.	60.
1.39E-10	4503.	60.
1.32E-10	4480.	60.
1.27E-10	4455.	60.
1.20E-10	4435.	60.
1.15E-10	4415.	60.
1.05E-10	4385.	60.
1.00E-10	4350.	60.
0.90E-10	4327.	60.
0.82E-10	4300.	60.
0.77E-10	4277.	60.
0.71E-10	4247.	60.
0.69E-10	4220.	60.
0.68E-10	4190.	60.
0.64E-10	4170.	60.
0.61E-10	4105.	120.
0.60E-10	4045.	120.
0.60E-10	3980.	120.
0.61E-10	3920.	120.
0.62E-10	3860.	120.
0.61E-10	3800.	120.
0.60E-10	3740.	120.
0.61E-10	3680.	120.
0.70E-10	3615.	120.
0.80E-10	3550.	120.
0.89E-10	3485.	120.
0.95E-10	3420.	120.
0.99E-10	3350.	120.
1.00E-10	3290.	120.
1.00E-10	3230.	120.
1.02E-10	3170.	120.
1.13E-10	3100.	120.
1.34E-10	3040.	120.
1.57E-10	2980.	120.
2.00E-10	2905.	120.
2.65E-10	2840.	120.

3.60E-10	2780.	120.
5.30E-10	2710.	120.
6.30E-10	2690.	60.
8.00E-10	2650.	60.
9.20E-10	2620.	60.
10.0E-10	2590.	60.
12.0E-10	2550.	60.
14.5E-10	2510.	60.
17.1E-10	2473.	60.
17.5E-10	2435.	60.
15.2E-10	2400.	60.
11.0E-10	2370.	60.
5.80E-10	2330.	60.
4.20E-10	2300.	60.
3.30E-10	2265.	60.
2.78E-10	2230.	60.
2.33E-10	2165.	120.
2.03E-10	2090.	120.
1.83E-10	2010.	120.
1.70E-10	1935.	120.
1.58E-10	1850.	120.
1.48E-10	1770.	120.
1.40E-10	1700.	120.

SAMPLE # RTF2 RUN # F154 9/16/82
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
FROZEN UNDER A 12 PSI VACUUM

83	20.	0.019
0.37E-10	5170.	0.0
0.58E-10	5133.	60.
0.88E-10	5103.	60.
1.40E-10	5080.	60.
2.00E-10	5057.	60.
2.75E-10	5030.	60.
3.52E-10	5005.	60.
4.35E-10	4985.	60.
5.00E-10	4968.	60.
5.80E-10	4947.	60.
6.30E-10	4920.	60.
6.70E-10	4900.	60.
6.70E-10	4875.	60.
6.22E-10	4852.	60.
5.40E-10	4825.	60.
4.50E-10	4800.	60.
3.50E-10	4780.	60.
2.90E-10	4760.	60.
2.20E-10	4735.	60.
1.74E-10	4710.	60.
1.40E-10	4685.	60.
1.10E-10	4660.	60.
0.90E-10	4635.	60.
0.80E-10	4610.	60.
0.73E-10	4590.	60.
0.67E-10	4567.	60.
0.68E-10	4537.	60.
0.70E-10	4510.	60.
0.72E-10	4490.	60.
0.75E-10	4470.	60.
0.83E-10	4430.	60.
0.90E-10	4405.	60.
1.00E-10	4385.	60.
1.10E-10	4362.	60.
1.00E-10	4335.	60.
0.95E-10	4310.	60.
0.90E-10	4288.	60.
0.79E-10	4263.	60.
0.65E-10	4235.	60.
0.60E-10	4207.	60.
0.48E-10	4182.	60.
0.37E-10	4158.	60.
0.31E-10	4130.	60.
0.25E-10	4080.	120.
0.31E-10	4040.	120.
0.40E-10	3970.	120.
0.52E-10	3910.	120.
0.68E-10	3850.	120.
0.60E-10	3790.	120.
0.48E-10	3735.	120.
0.47E-10	3675.	120.
0.49E-10	3615.	120.
0.60E-10	3555.	120.
0.65E-10	3480.	120.
0.70E-10	3405.	120.
0.70E-10	3330.	120.
0.66E-10	3275.	120.
0.60E-10	3205.	120.
0.62E-10	3150.	120.
0.75E-10	3080.	120.

0.95E-10	3015.	120.
1.30E-10	2960.	120.
1.80E-10	2890.	120.
2.40E-10	2820.	120.
3.02E-10	2755.	120.
3.26E-10	2690.	120.
3.30E-10	2630.	120.
3.09E-10	2570.	120.
3.13E-10	2500.	120.
3.37E-10	2425.	120.
3.60E-10	2355.	120.
3.70E-10	2280.	120.
3.92E-10	2210.	120.
4.38E-10	2135.	120.
4.90E-10	2065.	120.
5.50E-10	1990.	120.
6.20E-10	1915.	120.
6.90E-10	1830.	120.
7.88E-10	1765.	120.
8.40E-10	1695.	120.
9.30E-10	1620.	120.
10.0E-10	1540.	120.
10.2E-10	1460.	120.

SAMPLE THICKNESS=.375 in. PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019

0.34E-10	5130.	0.0
0.53E-10	5110.	60.
0.87E-10	5095.	60.
1.15E-10	5080.	60.
1.35E-10	5065.	60.
1.90E-10	5047.	60.
2.73E-10	5020.	60.
4.00E-10	5000.	60.
5.00E-10	4980.	60.
6.50E-10	4957.	60.
8.00E-10	4929.	60.
9.90E-10	4900.	60.
10.8E-10	4880.	60.
10.9E-10	4858.	60.
10.5E-10	4833.	60.
9.00E-10	4805.	60.
6.50E-10	4785.	60.
4.80E-10	4760.	60.
3.00E-10	4730.	60.
2.00E-10	4710.	60.
1.30E-10	4690.	60.
0.90E-10	4665.	60.
0.62E-10	4635.	60.
0.42E-10	4610.	60.
0.39E-10	4590.	60.
0.32E-10	4570.	60.
0.30E-10	4550.	60.
0.30E-10	4525.	60.
0.31E-10	4500.	60.
0.31E-10	4472.	60.
0.32E-10	4445.	60.
0.34E-10	4420.	60.
0.37E-10	4395.	60.
0.40E-10	4365.	60.
0.39E-10	4337.	60.
0.37E-10	4312.	60.
0.32E-10	4290.	60.
0.23E-10	4270.	60.
0.13E-10	4205.	120.
0.10E-10	4150.	120.
0.10E-10	4095.	120.
0.10E-10	4045.	120.
0.10E-10	3980.	120.
0.10E-10	3920.	120.
0.10E-10	3855.	120.
0.05E-10	3800.	120.
0.05E-10	3730.	120.
0.05E-10	3675.	120.
0.05E-10	3610.	120.
0.05E-10	3550.	120.
0.05E-10	3480.	120.
0.05E-10	3405.	120.
0.05E-10	3350.	120.
0.08E-10	3275.	120.
0.18E-10	3210.	120.
0.32E-10	3150.	120.
0.60E-10	3090.	120.
1.10E-10	3025.	120.
1.52E-10	2970.	120.
1.98E-10	2905.	120.

1.89E-10	2835.	120.
1.55E-10	2770.	120.
1.10E-10	2700.	120.
0.90E-10	2630.	120.
0.80E-10	2575.	120.
0.90E-10	2500.	120.
1.08E-10	2430.	120.
1.32E-10	2370.	120.
1.62E-10	2300.	120.
1.98E-10	2220.	120.
2.23E-10	2150.	120.
2.50E-10	2090.	120.
2.90E-10	2005.	120.
3.35E-10	1920.	120.
3.70E-10	1835.	120.
4.10E-10	1765.	120.
4.60E-10	1695.	120.
5.00E-10	1660.	60.
5.40E-10	1620.	60.
5.50E-10	1580.	60.
5.52E-10	1535.	60.
5.50E-10	1460.	120.
5.28E-10	1385.	120.

SAMPLE# RSST3 RUN# F162 10/13/82
SAMPLE THICKNESS=.375in. PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI

83	20.	0.019
0.58E-10	5175.	0.0
0.73E-10	5150.	60.
1.05E-10	5125.	60.
1.50E-10	5100.	60.
2.00E-10	5075.	60.
3.14E-10	5050.	60.
4.40E-10	5030.	60.
6.50E-10	5010.	60.
8.40E-10	4990.	60.
11.0E-10	4970.	60.
14.7E-10	4950.	60.
17.1E-10	4925.	60.
18.9E-10	4900.	60.
19.8E-10	4875.	60.
19.8E-10	4850.	60.
19.0E-10	4825.	60.
17.2E-10	4800.	60.
15.0E-10	4775.	60.
12.0E-10	4750.	60.
7.80E-10	4725.	60.
5.00E-10	4700.	60.
4.20E-10	4675.	60.
3.10E-10	4650.	60.
2.50E-10	4625.	60.
2.02E-10	4600.	60.
1.87E-10	4575.	60.
1.78E-10	4550.	60.
1.81E-10	4525.	60.
1.85E-10	4500.	60.
1.89E-10	4475.	60.
1.93E-10	4450.	60.
1.93E-10	4425.	60.
1.90E-10	4400.	60.
1.88E-10	4375.	60.
1.79E-10	4350.	60.
1.71E-10	4325.	60.
1.62E-10	4300.	60.
1.57E-10	4275.	60.
1.50E-10	4250.	60.
1.45E-10	4225.	60.
1.40E-10	4200.	60.
1.38E-10	4175.	60.
1.33E-10	4150.	60.
1.35E-10	4125.	60.
1.39E-10	4075.	120.
1.42E-10	4005.	120.
1.46E-10	3940.	120.
1.46E-10	3875.	120.
1.40E-10	3810.	120.
1.30E-10	3750.	120.
1.19E-10	3690.	120.
1.24E-10	3620.	120.
1.35E-10	3550.	120.
1.52E-10	3490.	120.
1.69E-10	3420.	120.
1.82E-10	3350.	120.
1.90E-10	3290.	120.
1.97E-10	3230.	120.
2.02E-10	3170.	120.
2.08E-10	3100.	120.

2.11E-10	3030.	120.
2.18E-10	2970.	120.
2.28E-10	2900.	120.
2.47E-10	2830.	120.
2.68E-10	2770.	120.
2.90E-10	2700.	120.
3.20E-10	2640.	120.
3.70E-10	2580.	120.
4.47E-10	2510.	120.
5.50E-10	2440.	120.
6.15E-10	2380.	120.
6.50E-10	2310.	120.
6.73E-10	2250.	120.
7.00E-10	2190.	120.
7.25E-10	2120.	120.
7.40E-10	2050.	120.
7.45E-10	1970.	120.
7.47E-10	1890.	120.
7.39E-10	1810.	120.
7.07E-10	1740.	120.
6.67E-10	1670.	120.
6.50E-10	1600.	120.
6.70E-10	1520.	120.

SAMPLE # PIF/1 RUN # F166 11/5/82
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
TEFLON BLOCKING LAYERS USED GUARD RING FLOATING DURING DISCHARGE

83	20.	0.019
0.18E-11	4870.	0.0
0.20E-11	4850.	60.
0.27E-11	4830.	60.
0.35E-11	4810.	60.
0.42E-11	4790.	60.
0.55E-11	4770.	60.
0.70E-11	4750.	60.
0.85E-11	4725.	60.
1.04E-11	4700.	60.
1.29E-11	4675.	60.
1.50E-11	4650.	60.
1.80E-11	4625.	60.
2.05E-11	4600.	60.
2.35E-11	4575.	60.
2.70E-11	4550.	60.
3.07E-11	4525.	60.
3.35E-11	4500.	60.
3.53E-11	4475.	60.
3.61E-11	4450.	60.
3.60E-11	4425.	60.
3.40E-11	4400.	60.
3.02E-11	4375.	60.
2.50E-11	4350.	60.
2.00E-11	4325.	60.
1.60E-11	4300.	60.
1.40E-11	4275.	60.
1.31E-11	4250.	60.
1.30E-11	4225.	60.
1.25E-11	4200.	60.
1.22E-11	4175.	60.
1.13E-11	4150.	60.
1.00E-11	4120.	60.
0.90E-11	4090.	60.
0.75E-11	4060.	60.
0.60E-11	4030.	60.
0.50E-11	4000.	60.
0.41E-11	3970.	60.
0.37E-11	3940.	60.
0.35E-11	3910.	60.
0.35E-11	3880.	60.
0.36E-11	3850.	60.
0.39E-11	3820.	60.
0.40E-11	3790.	60.
0.41E-11	3760.	60.
0.42E-11	3730.	60.
0.39E-11	3700.	60.
0.32E-11	3670.	60.
0.23E-11	3640.	60.
0.18E-11	3610.	60.
0.13E-11	3580.	60.
0.12E-11	3550.	60.
0.11E-11	3520.	60.
0.11E-11	3490.	120.
0.12E-11	3430.	120.
0.12E-11	3370.	120.
0.12E-11	3310.	120.
0.13E-11	3250.	120.
0.15E-11	3180.	120.
0.16E-11	3110.	120.
0.17E-11	3040.	120.

0.18E-11	2970.	120.
0.19E-11	2900.	120.
0.20E-11	2830.	120.
0.20E-11	2760.	120.
0.20E-11	2690.	120.
0.20E-11	2620.	120.
0.21E-11	2550.	120.
0.21E-11	2480.	120.
0.20E-11	2410.	120.
0.20E-11	2340.	120.
0.28E-11	2270.	120.
0.38E-11	2200.	120.
0.46E-11	2130.	120.
0.52E-11	2050.	120.
0.60E-11	1970.	120.
0.65E-11	1890.	120.
0.58E-11	1810.	120.
0.40E-11	1730.	120.
0.20E-11	1650.	120.
0.07E-11	1610.	60.
0.00E-11	1570.	60.
0.00E-11	1530.	60.
0.20E-11	1490.	60.

SAMPLE # PIF/1 RUN # F167 11/9/82
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
TEFLON BLOCKING LAYERS USED GUARD RING CONNECTED DURING DISCHARGING

83 20. 0.019

0.28E-11	4970.	0.0
0.30E-11	4950.	60.
0.34E-11	4925.	60.
0.41E-11	4900.	60.
0.50E-11	4875.	60.
0.63E-11	4850.	60.
0.80E-11	4825.	60.
1.02E-11	4800.	60.
1.33E-11	4775.	60.
1.70E-11	4750.	60.
2.10E-11	4725.	60.
2.65E-11	4700.	60.
3.25E-11	4675.	60.
3.85E-11	4650.	60.
4.50E-11	4625.	60.
4.95E-11	4600.	60.
5.37E-11	4575.	60.
5.62E-11	4550.	60.
5.69E-11	4525.	60.
5.47E-11	4500.	60.
5.05E-11	4475.	60.
4.53E-11	4450.	60.
3.97E-11	4425.	60.
3.40E-11	4400.	60.
2.90E-11	4375.	60.
2.52E-11	4350.	60.
1.98E-11	4300.	120.
1.82E-11	4275.	60.
1.80E-11	4250.	60.
1.83E-11	4225.	60.
1.89E-11	4200.	60.
1.91E-11	4175.	60.
1.89E-11	4150.	60.
1.82E-11	4125.	60.
1.78E-11	4100.	60.
1.69E-11	4075.	60.
1.58E-11	4050.	60.
1.49E-11	4025.	60.
1.39E-11	4000.	60.
1.29E-11	3975.	60.
1.21E-11	3950.	60.
1.13E-11	3920.	60.
1.10E-11	3890.	60.
1.15E-11	3860.	60.
1.30E-11	3830.	60.
1.52E-11	3800.	60.
1.80E-11	3770.	60.
2.08E-11	3740.	60.
2.20E-11	3710.	60.
2.20E-11	3680.	60.
2.19E-11	3650.	60.
2.15E-11	3620.	60.
2.07E-11	3590.	60.
1.90E-11	3560.	60.
1.80E-11	3530.	60.
1.50E-11	3500.	60.
1.10E-11	3470.	60.
0.80E-11	3410.	60.
0.70E-11	3350.	120.
0.69E-11	3290.	120.

0.77E-11	3230.	120.
0.80E-11	3170.	120.
0.90E-11	3110.	120.
0.99E-11	3040.	120.
1.10E-11	2970.	120.
1.09E-11	2900.	120.
0.83E-11	2830.	120.
0.40E-11	2760.	120.
0.50E-11	2620.	240.
0.60E-11	2550.	120.
0.76E-11	2480.	120.
1.20E-11	2410.	120.
2.20E-11	2340.	120.
3.78E-11	2270.	120.
3.40E-11	2200.	120.
1.90E-11	2130.	120.
1.03E-11	2060.	120.
1.00E-11	1990.	120.
1.28E-11	1920.	120.
1.45E-11	1850.	120.
1.30E-11	1780.	120.
1.08E-11	1640.	240.
1.10E-11	1500.	240.

SAMPLE # PIF/1 RUN # F169 11/15/82
SAMPLE THICKNESS=.375 in. PURE ICE VCH.=1500

37 20. 0.019

0.3E-11	4965.
0.4E-11	4910.
0.5E-11	4890.
0.7E-11	4855.
0.9E-11	4825.
1.2E-11	4800.
1.5E-11	4785.
2.0E-11	4756.
2.5E-11	4730.
3.0E-11	4705.
3.7E-11	4685.
4.3E-11	4665.
4.8E-11	4630.
5.2E-11	4610.
5.4E-11	4600.
5.5E-11	4575.
5.4E-11	4550.
5.2E-11	4525.
4.7E-11	4500.
4.2E-11	4478.
3.8E-11	4455.
3.5E-11	4425.
3.2E-11	4400.
2.9E-11	4390.
2.5E-11	4370.
2.2E-11	4345.
2.0E-11	4320.
1.8E-11	4290.
1.77E-11	4275.
1.8E-11	4220.
1.9E-11	4195.
1.9E-11	4150.
1.8E-11	4110.
1.7E-11	4095.
1.5E-11	4050.
1.3E-11	4020.
1.0E-11	3985.

SAMPLE # RSST6 RUN # F170 11/19/82
SAMPLE THICKNESS=.375 in. PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI

83	20.	0.019
0.40E-10	5150.	0.0
0.60E-10	5125.	60.
0.83E-10	5100.	60.
1.08E-10	5075.	60.
1.40E-10	5050.	60.
1.80E-10	5030.	60.
2.10E-10	5010.	60.
2.40E-10	4990.	60.
2.67E-10	4970.	60.
3.00E-10	4950.	60.
3.25E-10	4925.	60.
3.53E-10	4905.	60.
3.90E-10	4885.	60.
4.20E-10	4865.	60.
4.50E-10	4845.	60.
4.60E-10	4822.	60.
4.57E-10	4800.	60.
4.40E-10	4775.	60.
4.15E-10	4750.	60.
3.75E-10	4725.	60.
3.40E-10	4700.	60.
3.07E-10	4675.	60.
2.68E-10	4650.	60.
2.43E-10	4625.	60.
2.30E-10	4600.	60.
2.20E-10	4575.	60.
2.21E-10	4550.	60.
2.40E-10	4525.	60.
2.62E-10	4500.	60.
2.93E-10	4475.	60.
3.27E-10	4450.	60.
3.65E-10	4425.	60.
4.15E-10	4400.	60.
5.00E-10	4375.	60.
5.70E-10	4350.	60.
6.30E-10	4325.	60.
7.05E-10	4300.	60.
7.50E-10	4275.	60.
7.83E-10	4250.	60.
7.88E-10	4225.	60.
7.70E-10	4200.	60.
6.90E-10	4170.	60.
6.10E-10	4140.	60.
4.70E-10	4080.	120.
3.85E-10	4020.	120.
3.76E-10	3990.	60.
3.72E-10	3960.	60.
3.79E-10	3930.	60.
4.00E-10	3900.	60.
4.33E-10	3860.	60.
4.61E-10	3830.	60.
4.53E-10	3800.	60.
4.17E-10	3770.	60.
3.80E-10	3740.	60.
2.90E-10	3670.	120.
2.00E-10	3600.	120.
1.63E-10	3530.	120.
1.60E-10	3430.	180.
1.62E-10	3340.	180.
1.71E-10	3250.	180.

1.86E-10	3160.	180.
2.00E-10	3070.	180.
2.19E-10	2980.	180.
2.30E-10	2880.	180.
2.53E-10	2780.	180.
2.79E-10	2710.	120.
3.10E-10	2643.	120.
3.38E-10	2580.	120.
3.81E-10	2510.	120.
4.30E-10	2435.	120.
4.80E-10	2365.	120.
5.35E-10	2290.	120.
5.95E-10	2215.	120.
6.72E-10	2140.	120.
7.80E-10	2065.	120.
9.30E-10	1990.	120.
11.0E-10	1915.	120.
11.5E-10	1840.	120.
11.2E-10	1765.	120.
10.1E-10	1690.	120.
10.0E-10	1615.	120.
8.90E-10	1540.	120.
8.20E-10	1500.	60.

SAMPLE # PIF/2 RUN # F174 12/1/82

SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500

TEFLON BLOCKING LAYERS USED GUARD RING FLOATING DURING DISCHARGING

83 20. 0.019

0.09E-11	4990.	0.0
0.10E-11	4970.	60.
0.23E-11	4950.	60.
0.30E-11	4930.	60.
0.36E-11	4910.	60.
0.48E-11	4890.	60.
0.62E-11	4870.	60.
0.82E-11	4850.	60.
1.10E-11	4825.	60.
1.45E-11	4800.	60.
1.90E-11	4775.	60.
2.40E-11	4750.	60.
2.93E-11	4725.	60.
3.40E-11	4700.	60.
3.71E-11	4675.	60.
3.82E-11	4650.	60.
3.71E-11	4625.	60.
3.38E-11	4600.	60.
2.95E-11	4575.	60.
2.40E-11	4550.	60.
1.80E-11	4525.	60.
1.30E-11	4500.	60.
1.00E-11	4475.	60.
0.80E-11	4450.	60.
0.70E-11	4425.	60.
0.65E-11	4400.	60.
0.66E-11	4375.	60.
0.67E-11	4350.	60.
0.68E-11	4325.	60.
0.70E-11	4300.	60.
0.76E-11	4275.	60.
0.80E-11	4250.	60.
0.79E-11	4225.	60.
0.75E-11	4200.	60.
0.66E-11	4170.	60.
0.52E-11	4140.	60.
0.40E-11	4110.	60.
0.28E-11	4080.	60.
0.20E-11	4050.	60.
0.17E-11	4020.	60.
0.10E-11	3990.	60.
0.08E-11	3960.	60.
0.05E-11	3930.	60.
0.02E-11	3900.	60.
0.00E-11	3870.	60.
0.00E-11	3840.	60.
0.00E-11	3810.	60.
0.00E-11	3780.	60.
0.05E-11	3720.	120.
0.06E-11	3660.	120.
0.07E-11	3600.	120.
0.05E-11	3540.	120.
0.04E-11	3480.	120.
0.02E-11	3420.	120.
0.00E-11	3360.	120.
0.00E-11	3300.	120.
0.05E-11	3240.	120.
0.05E-11	3180.	120.
0.06E-11	3120.	120.
0.07E-11	3060.	120.

0.10E-11	3000.	120.
0.10E-11	2930.	120.
0.10E-11	2860.	120.
0.10E-11	2790.	120.
0.10E-11	2720.	120.
0.11E-11	2640.	120.
0.12E-11	2560.	120.
0.12E-11	2480.	120.
0.12E-11	2400.	120.
0.11E-11	2320.	120.
0.00E-11	2240.	120.
0.00E-11	2160.	120.
0.00E-11	2080.	120.
0.00E-11	2000.	120.
0.00E-11	1920.	120.
0.00E-11	1840.	120.
0.00E-11	1760.	120.
0.00E-11	1720.	60.
0.00E-11	1680.	60.
0.00E-11	1640.	60.
0.00E-11	1600.	60.
0.00E-11	1560.	60.
0.00E-11	1520.	60.

SAMPLE # PIF/2 RUN # F175 12/6/82
SAMPLE THICKNESS=0.375inches PURE ICE VCH.=1500
TEFLON BLOCKING LAYERS USED GUARD RING CONNECTED DURING DISCHARGING

83	20.	0.019
0.30E-11	5090.	0.0
0.31E-11	5070.	60.
0.32E-11	5050.	60.
0.39E-11	5030.	60.
0.41E-11	5010.	60.
0.47E-11	4990.	60.
0.52E-11	4970.	60.
0.60E-11	4950.	60.
0.69E-11	4925.	60.
0.80E-11	4900.	60.
0.97E-11	4875.	60.
1.20E-11	4850.	60.
1.50E-11	4825.	60.
1.90E-11	4800.	60.
2.38E-11	4775.	60.
2.97E-11	4750.	60.
3.65E-11	4725.	60.
4.43E-11	4700.	60.
5.07E-11	4675.	60.
5.45E-11	4650.	60.
5.52E-11	4625.	60.
5.30E-11	4600.	60.
4.80E-11	4575.	60.
4.17E-11	4550.	60.
3.50E-11	4525.	60.
2.77E-11	4500.	60.
2.00E-11	4475.	60.
1.50E-11	4450.	60.
1.20E-11	4425.	60.
1.07E-11	4400.	60.
1.01E-11	4375.	60.
0.98E-11	4350.	60.
0.98E-11	4325.	60.
1.00E-11	4300.	60.
1.02E-11	4275.	60.
1.05E-11	4250.	60.
1.11E-11	4225.	60.
1.13E-11	4200.	60.
1.11E-11	4175.	60.
1.08E-11	4150.	60.
0.90E-11	4125.	60.
0.77E-11	4100.	60.
0.60E-11	4075.	60.
0.49E-11	4050.	60.
0.40E-11	4025.	60.
0.32E-11	4000.	60.
0.29E-11	3970.	60.
0.25E-11	3940.	60.
0.22E-11	3910.	60.
0.20E-11	3850.	120.
0.25E-11	3790.	120.
0.27E-11	3730.	120.
0.30E-11	3670.	120.
0.33E-11	3610.	120.
0.40E-11	3550.	120.
0.60E-11	3490.	120.
1.08E-11	3430.	120.
0.90E-11	3370.	120.
0.60E-11	3300.	120.
0.33E-11	3230.	120.

0.30E-11	3160.	120.
0.30E-11	3090.	120.
0.31E-11	3020.	120.
0.32E-11	2950.	120.
0.33E-11	2880.	120.
0.35E-11	2810.	120.
0.38E-11	2740.	120.
0.40E-11	2670.	120.
0.43E-11	2600.	120.
0.51E-11	2530.	120.
0.70E-11	2460.	120.
0.86E-11	2390.	120.
1.20E-11	2320.	120.
1.33E-11	2250.	120.
1.39E-11	2180.	120.
1.65E-11	2110.	120.
3.60E-11	2040.	120.
7.00E-11	1960.	120.
6.20E-11	1880.	120.
4.90E-11	1800.	120.
5.20E-11	1720.	120.
6.60E-11	1640.	120.
8.80E-11	1560.	60.

SAMPLE # RSST7 RUN # F178 12/12/82
SAMPLE THICKNESS=0.375inches (83) PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI

51 20. 0.019

0.7E-10	5135.	60.
1.2E-10	5105.	60.
2.0E-10	5070.	60.
2.9E-10	5047.	60.
4.5E-10	5020.	60.
5.6E-10	5004.	60.
7.3E-10	4980.	60.
8.7E-10	4960.	60.
10.0E-10	4940.	60.
11.0E-10	4920.	60.
12.5E-10	4895.	60.
13.0E-10	4880.	60.
13.0E-10	4850.	60.
12.5E-10	4820.	60.
10.0E-10	4790.	60.
8.5E-10	4774.	60.
7.1E-10	4745.	60.
5.0E-10	4720.	60.
4.0E-10	4700.	60.
3.4E-10	4680.	60.
3.1E-10	4650.	60.
3.02E-10	4620.	60.
3.05E-10	4600.	60.
3.15E-10	4580.	60.
3.35E-10	4550.	60.
3.7E-10	4520.	60.
4.15E-10	4500.	60.
4.5E-10	4480.	60.
4.9E-10	4450.	60.
5.3E-10	4425.	60.
5.7E-10	4405.	60.
6.3E-10	4380.	60.
6.83E-10	4350.	60.
7.0E-10	4330.	60.
6.9E-10	4300.	60.
6.6E-10	4280.	60.
6.0E-10	4256.	60.
5.4E-10	4224.	60.
4.7E-10	4200.	60.
4.0E-10	4180.	60.
3.3E-10	4140.	60.
2.7E-10	4115.	60.
2.25E-10	4090.	60.
2.0E-10	4060.	60.
1.85E-10	4030.	60.
1.7E-10	3975.	120.
1.6E-10	3900.	120.
1.58E-10	3835.	120.
1.55E-10	3790.	120.
1.5E-10	3705.	120.
1.5E-10	3650.	120.
1.58E-10	3595.	120.
1.70E-10	3520.	120.
1.96E-10	3470.	120.
2.35E-10	3390.	120.
2.75E-10	3330.	120.
3.20E-10	3270.	120.
3.80E-10	3200.	120.
4.45E-10	3135.	120.
5.15E-10	3075.	120.

6.07E-10	3010.	120.
6.80E-10	2945.	120.
7.30E-10	2885.	120.
7.70E-10	2805.	120.
7.95E-10	2745.	120.
8.17E-10	2695.	120.
8.31E-10	2615.	120.
8.48E-10	2530.	120.
8.59E-10	2465.	120.
8.61E-10	2400.	120.
8.63E-10	2330.	120.
8.60E-10	2270.	120.
9.00E-10	2185.	120.
9.73E-10	2105.	120.
10.2E-10	2031.	120.
11.9E-10	1970.	120.
14.9E-10	1840.	180.
17.5E-10	1780.	120.
21.3E-10	1700.	120.
26.5E-10	1620.	120.
28.5E-10	1530.	120.
29.0E-10	1500.	60.
28.8E-10	1470.	60.

SAMPLE # RS317 RUN # 1179 [illegible]
SAMPLE THICKNESS=0.375 inches (51) PURE ICE VCH.=1000
FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019
0.5E-10 5180. 60.
0.7E-10 5150. 60.
1.2E-10 5120. 60.
1.6E-10 5100. 60.
2.2E-10 5085. 60.
2.8E-10 5060. 60.
4.6E-10 5020. 60.
5.6E-10 5000. 60.
7.0E-10 4970. 60.
8.3E-10 4940. 60.
9.15E-10 4915. 60.
9.38E-10 4900. 60.
9.32E-10 4880. 60.
9.0E-10 4865. 60.
8.3E-10 4830. 60.
6.8E-10 4800. 60.
5.7E-10 4780. 60.
4.4E-10 4750. 60.
2.5E-10 4700. 60.
2.15E-10 4680. 60.
2.0E-10 4650. 60.
1.88E-10 4630. 60.
1.85E-10 4600. 60.
1.88E-10 4580. 60.
1.95E-10 4550. 60.
2.05E-10 4520. 60.
2.28E-10 4500. 60.
2.5E-10 4480. 60.
2.78E-10 4450. 60.
3.07E-10 4425. 60.
3.5E-10 4400. 60.
3.8E-10 4380. 60.
3.9E-10 4350. 60.
3.95E-10 4330. 60.
3.9E-10 4300. 60.
3.77E-10 4280. 60.
3.45E-10 4250. 60.
3.1E-10 4220. 60.
2.75E-10 4195. 60.
1.8E-10 4130. 60.
1.5E-10 4105. 60.
1.28E-10 4080. 60.
1.1E-10 4050. 60.
0.9E-10 4000. 60.
0.8E-10 3935. 120.
0.77E-10 3870. 120.
0.75E-10 3805. 120.
0.73E-10 3750. 120.
0.75E-10 3680. 120.
0.78E-10 3625. 120.
0.83E-10 3560. 120.
0.91E-10 3490. 120.
1.00E-10 3420. 120.
1.13E-10 3365. 120.
1.30E-10 3295. 120.
1.50E-10 3230. 120.
1.75E-10 3170. 120.
2.02E-10 3110. 120.
2.43E-10 3050. 120.
2.82E-10 2990. 120.

3.27E-10	2905.	120.
3.63E-10	2850.	120.
3.85E-10	2795.	120.
4.03E-10	2720.	120.
4.20E-10	2660.	120.
4.42E-10	2595.	120.
4.72E-10	2505.	120.
5.02E-10	2440.	120.
5.37E-10	2375.	120.
5.61E-10	2300.	120.
5.71E-10	2230.	120.
5.95E-10	2170.	120.
6.58E-10	2090.	120.
7.40E-10	2009.	120.
8.10E-10	1981.	60.
8.80E-10	1945.	60.
9.30E-10	1905.	60.
10.0E-10	1865.	60.
12.0E-10	1780.	120.
14.2E-10	1710.	120.
17.8E-10	1625.	120.
20.0E-10	1540.	120.
20.5E-10	1475.	120.

SAMPLE THICKNESS=0.375inches (51) PURE ICE VCH.=500
FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019
0.23E-10 5170. 60.
0.32E-10 5140. 60.
0.48E-10 5120. 60.
0.75E-10 5100. 60.
1.05E-10 5075. 60.
1.7E-10 5035. 60.
2.1E-10 5020. 60.
2.8E-10 4990. 60.
3.6E-10 4975. 60.
4.2E-10 4950. 60.
4.9E-10 4930. 60.
5.25E-10 4900. 60.
5.3E-10 4880. 60.
5.22E-10 4865. 60.
4.85E-10 4840. 60.
4.1E-10 4805. 60.
3.6E-10 4790. 60.
2.8E-10 4775. 60.
2.0E-10 4750. 60.
1.5E-10 4705. 60.
1.3E-10 4695. 60.
1.0E-10 4675. 60.
0.95E-10 4650. 60.
0.90E-10 4620. 60.
0.88E-10 4600. 60.
0.85E-10 4575. 60.
0.88E-10 4550. 60.
0.95E-10 4520. 60.
1.0E-10 4500. 60.
1.15E-10 4475. 60.
1.25E-10 4445. 60.
1.4E-10 4410. 60.
1.5E-10 4390. 60.
1.55E-10 4375. 60.
1.55E-10 4335. 60.
1.5E-10 4320. 60.
1.4E-10 4290. 60.
1.2E-10 4275. 60.
1.1E-10 4240. 60.
0.9E-10 4200. 60.
0.75E-10 4185. 60.
0.55E-10 4125. 120.
0.4E-10 4075. 120.
0.33E-10 4005. 120.
0.3E-10 3950. 120.
0.3E-10 3880. 120.
0.3E-10 3820. 120.
0.3E-10 3760. 120.
0.3E-10 3700. 120.
0.3E-10 3630. 120.
0.33E-10 3575. 120.
0.40E-10 3500. 120.
0.43E-10 3460. 120.
0.50E-10 3400. 120.
0.70E-10 3330. 120.
0.85E-10 3265. 120.
1.05E-10 3205. 120.
1.30E-10 3150. 120.
1.55E-10 3090. 120.
1.85E-10 3020. 120.

2.10E-10	2950.	120.
2.28E-10	2890.	120.
2.37E-10	2810.	120.
2.40E-10	2750.	120.
2.41E-10	2700.	120.
2.5E-10	2620.	120.
2.70E-10	2570.	120.
2.94E-10	2475.	120.
3.20E-10	2415.	120.
3.43E-10	2345.	120.
3.58E-10	2290.	120.
3.75E-10	2205.	120.
3.95E-10	2120.	120.
4.40E-10	2050.	120.
5.10E-10	1980.	120.
6.00E-10	1900.	120.
7.05E-10	1820.	120.
8.10E-10	1750.	120.
9.40E-10	1680.	120.
11.7E-10	1630.	60.
14.3E-10	1600.	60.
14.3E-10	1505.	120.
13.5E-10	1430.	120.

SAMPLE # P1F/3 RUN # F181 12/16/82
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
TEFLON BLOCKING LAYERS USED GUARD RING FLOATING DURING DISCHARGING

83 20. 0.019

0.23E-11	4820.	0.0
0.24E-11	4800.	60.
0.25E-11	4780.	60.
0.26E-11	4760.	60.
0.27E-11	4740.	60.
0.29E-11	4720.	60.
0.34E-11	4700.	60.
0.40E-11	4675.	60.
0.54E-11	4650.	60.
0.70E-11	4625.	60.
0.95E-11	4600.	60.
1.30E-11	4575.	60.
1.70E-11	4550.	60.
2.10E-11	4525.	60.
2.47E-11	4500.	60.
2.82E-11	4475.	60.
2.96E-11	4450.	60.
2.96E-11	4425.	60.
2.80E-11	4400.	60.
2.45E-11	4375.	60.
2.00E-11	4350.	60.
1.65E-11	4325.	60.
1.40E-11	4300.	60.
1.29E-11	4275.	60.
1.32E-11	4250.	60.
1.49E-11	4225.	60.
1.62E-11	4200.	60.
1.70E-11	4175.	60.
1.63E-11	4150.	60.
1.49E-11	4120.	60.
1.31E-11	4090.	60.
1.15E-11	4060.	60.
0.99E-11	4030.	60.
0.84E-11	4000.	60.
0.72E-11	3970.	60.
0.65E-11	3940.	60.
0.61E-11	3910.	60.
0.61E-11	3880.	60.
0.65E-11	3850.	60.
0.70E-11	3820.	60.
0.82E-11	3790.	60.
0.98E-11	3760.	60.
1.12E-11	3730.	60.
1.20E-11	3700.	60.
1.15E-11	3670.	60.
0.94E-11	3640.	60.
0.60E-11	3610.	60.
0.33E-11	3580.	60.
0.18E-11	3520.	120.
0.19E-11	3460.	120.
0.19E-11	3400.	120.
0.19E-11	3340.	120.
0.19E-11	3280.	120.
0.19E-11	3220.	120.
0.19E-11	3160.	120.
0.18E-11	3100.	120.
0.18E-11	3030.	120.
0.18E-11	2960.	120.
0.19E-11	2890.	120.
0.20E-11	2820.	120.

0.21E-11	2750.	120.
0.23E-11	2680.	120.
0.28E-11	2610.	120.
0.32E-11	2540.	120.
0.38E-11	2460.	120.
0.41E-11	2380.	120.
0.43E-11	2300.	120.
0.43E-11	2220.	120.
0.37E-11	2140.	120.
0.05E-11	2060.	120.
0.00E-11	1980.	120.
0.00E-11	1940.	60.
0.00E-11	1900.	60.
0.00E-11	1860.	60.
0.00E-11	1820.	60.
0.00E-11	1780.	60.
0.00E-11	1740.	60.
0.00E-11	1700.	60.
0.00E-11	1660.	60.
0.00E-11	1620.	60.
0.00E-11	1580.	60.
0.00E-11	1540.	60.
0.00E-11	1500.	60.

SAMPLE # RSST8 RUN # F182 1/20/83

SAMPLE THICKNESS=0.375 in. (51) PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

83	20.	0.019
0.28E-10	5140.	0.0
0.50E-10	5115.	60.
0.70E-10	5090.	60.
1.13E-10	5060.	60.
1.50E-10	5040.	60.
2.00E-10	5015.	60.
2.50E-10	5000.	60.
3.00E-10	4985.	60.
3.65E-10	4970.	60.
4.60E-10	4935.	60.
5.40E-10	4918.	60.
6.60E-10	4895.	60.
8.20E-10	4873.	60.
9.20E-10	4850.	60.
10.0E-10	4829.	60.
12.0E-10	4800.	60.
13.0E-10	4780.	60.
14.0E-10	4730.	60.
14.0E-10	4700.	60.
13.0E-10	4670.	120.
12.5E-10	4640.	60.
12.0E-10	4600.	90.
12.5E-10	4550.	120.
13.0E-10	4520.	60.
13.5E-10	4500.	60.
13.9E-10	4475.	60.
14.2E-10	4420.	90.
13.7E-10	4395.	90.
13.0E-10	4370.	60.
11.5E-10	4330.	90.
10.0E-10	4300.	60.
8.0E-10	4270.	60.
7.0E-10	4250.	60.
4.92E-10	4205.	90.
4.65E-10	4190.	60.
4.45E-10	4150.	60.
4.32E-10	4110.	60.
4.28E-10	4100.	60.
4.30E-10	4070.	60.
4.33E-10	4030.	60.
4.65E-10	3980.	120.
5.15E-10	3900.	120.
5.67E-10	3840.	120.
5.90E-10	3785.	120.
6.10E-10	3710.	120.
6.20E-10	3650.	120.
6.30E-10	3590.	120.
8.0E-10	3525.	120.
8.9E-10	3455.	120.
9.7E-10	3390.	120.
10.1E-10	3330.	120.
10.8E-10	3270.	120.
11.0E-10	3200.	120.
11.1E-10	3150.	120.
11.2E-10	3075.	120.
11.2E-10	3010.	120.
11.2E-10	2950.	120.
11.2E-10	2880.	120.
11.3E-10	2835.	60.
11.4E-10	2805.	60.

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11.6E-10 2735. 120.
12.0E-10 2680. 120.
12.7E-10 2605. 120.
13.7E-10 2530. 120.
14.8E-10 2475. 120.
15.3E-10 2430. 60.
16.2E-10 2395. 60.
17.3E-10 2325. 120.
18.0E-10 2270. 120.
20.0E-10 2185. 120.
20.9E-10 2100. 120.
21.45E-10 2060. 60.
21.8E-10 2020. 60.
23.0E-10 1960. 120.
23.25E-10 1975. 60.
23.5E-10 1890. 60.
23.5E-10 1850. 60.
23.4E-10 1805. 60.
23.3E-10 1725. 120.
23.0E-10 1665. 120.
22.0E-10 1580. 120.
21.5E-10 1535. 60.
20.2E-10 1465. 120.
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FIRST REFREEZE OF RSST8 RUN # F183 1/23/83

SAMPLE THICKNESS=0.375 inches (51) PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019

0.5E-10	5120.	0.0
0.75E-10	5100.	60.
1.30E-10	5070.	60.
1.94E-10	5040.	60.
2.80E-10	5020.	60.
3.90E-10	5000.	60.
5.00E-10	4980.	60.
6.20E-10	4957.	60.
7.20E-10	4930.	60.
8.50E-10	4907.	60.
11.0E-10	4880.	60.
12.0E-10	4860.	60.
13.8E-10	4830.	60.
15.0E-10	4800.	60.
15.2E-10	4790.	60.
15.2E-10	4770.	60.
14.8E-10	4739.	60.
13.2E-10	4710.	60.
12.0E-10	4695.	60.
10.0E-10	4680.	60.
8.80E-10	4637.	60.
8.05E-10	4615.	60.
7.84E-10	4600.	60.
7.90E-10	4580.	60.
8.10E-10	4530.	60.
8.25E-10	4520.	60.
8.30E-10	4500.	60.
8.30E-10	4480.	60.
8.10E-10	4430.	60.
7.85E-10	4410.	60.
6.70E-10	4390.	60.
5.60E-10	4370.	60.
4.80E-10	4335.	60.
4.00E-10	4308.	60.
3.35E-10	4290.	60.
2.90E-10	4260.	60.
2.60E-10	4220.	60.
2.40E-10	4205.	60.
2.20E-10	4180.	60.
2.13E-10	4155.	60.
2.15E-10	4120.	60.
2.17E-10	4065.	60.
2.30E-10	4030.	120.
2.42E-10	3985.	120.
2.50E-10	3900.	120.
2.55E-10	3835.	120.
2.65E-10	3785.	120.
2.71E-10	3710.	120.
2.87E-10	3670.	120.
3.10E-10	3600.	120.
3.35E-10	3520.	120.
3.6E-10	3465.	120.
3.85E-10	3395.	120.
4.12E-10	3325.	120.
4.35E-10	3270.	120.
4.63E-10	3200.	120.
5.0E-10	3155.	120.
5.5E-10	3090.	120.
6.4E-10	3020.	120.
8.1E-10	2955.	120.

10.0E-10	2890.	120.
12.5E-10	2820.	120.
15.5E-10	2750.	120.
20.0E-10	2685.	120.
24.0E-10	2620.	120.
28.5E-10	2545.	120.
32.3E-10	2485.	120.
34.4E-10	2395.	120.
34.8E-10	2320.	120.
33.0E-10	2270.	120.
30.0E-10	2195.	120.
28.0E-10	2120.	120.
27.0E-10	2030.	120.
26.3E-10	1975.	120.
26.1E-10	1920.	60.
25.8E-10	1885.	60.
24.7E-10	1800.	120.
23.9E-10	1765.	60.
23.0E-10	1725.	60.
22.0E-10	1655.	120.
21.0E-10	1580.	120.
20.4E-10	1535.	60.
19.8E-10	1450.	120.

THIRD REFREEZE OF SAMPLE # [illegible] RUN # [illegible] [illegible]

SAMPLE THICKNESS=0.375 in. (51) PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019

0.37E-10	5170.	0.0
0.5E-10	5135.	60.
0.65E-10	5120.	60.
1.05E-10	5100.	60.
1.8E-10	5075.	60.
2.6E-10	5050.	60.
3.7E-10	5020.	60.
5.3E-10	5000.	60.
6.9E-10	4980.	60.
8.4E-10	4950.	60.
9.8E-10	4930.	60.
12.0E-10	4910.	60.
14.5E-10	4883.	60.
16.2E-10	4865.	60.
17.8E-10	4835.	60.
18.3E-10	4805.	60.
18.0E-10	4790.	60.
16.0E-10	4761.	60.
13.3E-10	4730.	60.
11.0E-10	4705.	60.
9.0E-10	4695.	60.
7.2E-10	4670.	60.
6.1E-10	4635.	60.
5.5E-10	4610.	60.
5.2E-10	4600.	60.
5.0E-10	4580.	60.
4.8E-10	4545.	60.
4.6E-10	4515.	60.
4.5E-10	4500.	60.
4.3E-10	4480.	60.
4.1E-10	4430.	60.
3.8E-10	4400.	60.
3.2E-10	4382.	60.
2.7E-10	4350.	60.
2.3E-10	4325.	60.
2.05E-10	4300.	60.
1.8E-10	4280.	60.
1.7E-10	4250.	60.
1.61E-10	4220.	60.
1.55E-10	4200.	60.
1.52E-10	4175.	60.
1.52E-10	4150.	60.
1.58E-10	4115.	60.
1.60E-10	4085.	60.
1.75E-10	4020.	120.
1.95E-10	3975.	120.
2.20E-10	3890.	120.
2.35E-10	3825.	120.
2.45E-10	3770.	120.
2.50E-10	3705.	120.
2.58E-10	3640.	120.
2.64E-10	3590.	120.
2.80E-10	3515.	120.
2.9E-10	3450.	120.
3.02E-10	3390.	120.
3.10E-10	3305.	120.
3.20E-10	3260.	120.
3.35E-10	3200.	120.
3.55E-10	3125.	120.
3.85E-10	3075.	120.

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4.30E-10 3000. 120.
5.10E-10 2925. 120.
6.30E-10 2880. 120.
8.50E-10 2800. 120.
11.0E-10 2730. 120.
14.0E-10 2675. 120.
18.5E-10 2605. 120.
25.0E-10 2545. 120.
32.0E-10 2475. 120.
40.0E-10 2400. 120.
45.0E-10 2315. 120.
45.8E-10 2250. 120.
43.0E-10 2190. 120.
38.8E-10 2105. 120.
36.2E-10 2020. 120.
34.0E-10 1945. 120.
31.2E-10 1875. 120.
28.8E-10 1800. 120.
27.8E-10 1765. 60.
25.5E-10 1700. 120.
23.8E-10 1620. 120.
23.1E-10 1570. 60.
22.9E-10 1530. 60.
```

SAMPLE THICKNESS=0.375inches (51) PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

83 20. 0.019
0.52E-10 5125. 0.0
0.80E-10 5100. 60.
1.13E-10 5076. 60.
1.70E-10 5045. 60.
2.30E-10 5020. 60.
4.00E-10 4980. 120.
4.80E-10 4955. 60.
5.60E-10 4928. 60.
6.12E-10 4905. 60.
6.28E-10 4895. 60.
6.19E-10 4870. 60.
5.83E-10 4839. 60.
5.00E-10 4805. 60.
4.90E-10 4795. 60.
4.53E-10 4770. 60.
4.45E-10 4740. 60.
4.48E-10 4710. 60.
4.55E-10 4700. 60.
4.75E-10 4670. 60.
5.05E-10 4640. 60.
5.45E-10 4620. 60.
5.90E-10 4595. 60.
6.35E-10 4575. 60.
7.40E-10 4525. 120.
7.90E-10 4500. 60.
8.50E-10 4476. 60.
9.10E-10 4442. 60.
9.70E-10 4410. 60.
10.0E-10 4390. 60.
10.2E-10 4335. 120.
10.0E-10 4295. 120.
9.50E-10 4230. 120.
8.9E-10 4190. 60.
8.2E-10 4165. 120.
7.7E-10 4130. 60.
7.4E-10 4100. 60.
7.15E-10 4070. 60.
7.02E-10 4040. 60.
7.00E-10 4005. 60.
7.03E-10 3985. 60.
7.18E-10 3940. 60.
7.38E-10 3900. 60.
7.56E-10 3880. 60.
7.80E-10 3840. 60.
7.93E-10 3815. 60.
7.95E-10 3780. 60.
7.89E-10 3740. 60.
7.65E-10 3720. 60.
7.20E-10 3693. 60.
7.05E-10 3670. 60.
7.07E-10 3630. 60.
7.6E-10 3550. 120.
8.2E-10 3500. 120.
8.6E-10 3425. 120.
8.78E-10 3370. 120.
8.81E-10 3300. 120.
8.8E-10 3225. 120.
8.79E-10 3180. 120.
8.88E-10 3110. 120.
9.05E-10 3065. 120.

9.34E-10	2990.	120.
9.75E-10	2915.	120.
10.5E-10	2850.	120.
11.0E-10	2785.	120.
12.0E-10	2710.	120.
13.0E-10	2660.	120.
14.2E-10	2590.	120.
17.0E-10	2510.	120.
20.0E-10	2440.	120.
24.0E-10	2375.	120.
28.0E-10	2300.	120.
32.5E-10	2220.	120.
36.9E-10	2150.	120.
39.5E-10	2080.	120.
41.5E-10	2000.	120.
42.0E-10	1945.	120.
41.8E-10	1900.	60.
40.9E-10	1820.	120.
38.0E-10	1740.	120.
34.5E-10	1670.	120.
30.9E-10	1595.	120.
30.0E-10	1500.	120.
30.1E-10	1420.	120.

SAMPLE THICKNESS=0.375inches (51) PURE ICE VCH.=1500

FROZEN UNDER A VACUUM OF 12 PSI

76 20. 0.019

0.70E-10	5205.	0.0
0.90E-10	5195.	60.
1.30E-10	5180.	60.
1.90E-10	5143.	60.
2.80E-10	5120.	60.
4.00E-10	5095.	60.
5.40E-10	5075.	60.
6.60E-10	5050.	60.
8.40E-10	5020.	60.
9.70E-10	5005.	60.
11.0E-10	4985.	60.
12.0E-10	4960.	60.
12.7E-10	4934.	60.
12.9E-10	4907.	60.
12.0E-10	4888.	60.
10.0E-10	4863.	60.
8.60E-10	4839.	60.
6.60E-10	4809.	60.
5.20E-10	4795.	60.
4.30E-10	4775.	60.
4.00E-10	4730.	60.
3.88E-10	4710.	60.
3.82E-10	4700.	60.
3.78E-10	4670.	60.
3.82E-10	4630.	60.
4.00E-10	4610.	60.
4.23E-10	4594.	60.
4.60E-10	4560.	60.
5.10E-10	4530.	60.
5.50E-10	4505.	60.
6.10E-10	4490.	60.
6.40E-10	4470.	60.
6.57E-10	4430.	60.
6.47E-10	4400.	60.
6.35E-10	4388.	60.
5.90E-10	4365.	60.
5.30E-10	4337.	60.
4.50E-10	4320.	60.
4.00E-10	4295.	60.
3.30E-10	4250.	60.
2.85E-10	4222.	60.
2.10E-10	4200.	60.
1.70E-10	4175.	60.
1.40E-10	4135.	60.
1.26E-10	4110.	60.
1.20E-10	4090.	60.
1.20E-10	4050.	60.
1.20E-10	4025.	60.
1.25E-10	3975.	120.
1.35E-10	3900.	120.
1.43E-10	3835.	120.
1.58E-10	3780.	120.
1.70E-10	3710.	120.
1.88E-10	3650.	120.
2.15E-10	3590.	120.
2.45E-10	3520.	120.
2.85E-10	3450.	120.
3.4E-10	3380.	120.
3.8E-10	3310.	120.
4.3E-10	3255.	120.

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4.8E-10 3205. 120.
5.3E-10 3130. 120.
5.85E-10 3080. 120.
6.4E-10 3005. 120.
6.95E-10 2945. 120.
7.55E-10 2880. 120.
8.2E-10 2800. 120.
8.8E-10 2730. 120.
9.6E-10 2680. 120.
11.0E-10 2610. 120.
13.0E-10 2530. 120.
15.0E-10 2480. 120.
17.0E-10 2415. 120.
18.8E-10 2360. 120.
20.05E-10 2280. 120.
21.8E-10 2200. 120.
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THIRD REFREEZE OF SAMPLE # RSST9 RUN # F189 2/14/83
SAMPLE THICKNESS=0.375inches (51) PURE ICE VCH.=1500
FROZEN UNDER A VACUUM OF 12 PSI

83	20.	0.019
1.0E-10	5200.	0.0
1.4E-10	5175.	60.
2.3E-10	5135.	60.
3.2E-10	5110.	60.
5.1E-10	5090.	60.
6.6E-10	5065.	60.
8.4E-10	5045.	60.
10.0E-10	5020.	60.
12.0E-10	5000.	60.
13.5E-10	4975.	60.
13.87E-10	4960.	60.
14.0E-10	4935.	60.
13.7E-10	4906.	60.
12.7E-10	4885.	60.
11.0E-10	4863.	60.
9.0E-10	4830.	60.
7.5E-10	4805.	60.
5.0E-10	4782.	60.
4.3E-10	4762.	60.
3.85E-10	4735.	60.
3.60E-10	4715.	60.
3.5E-10	4700.	60.
3.45E-10	4675.	60.
3.6E-10	4635.	60.
3.9E-10	4610.	60.
4.4E-10	4580.	60.
4.8E-10	4559.	60.
5.1E-10	4535.	60.
5.4E-10	4510.	60.
5.7E-10	4492.	60.
6.15E-10	4460.	60.
6.2E-10	4435.	60.
5.8E-10	4405.	60.
5.4E-10	4390.	60.
4.7E-10	4365.	60.
4.1E-10	4345.	60.
3.6E-10	4309.	60.
3.1E-10	4280.	60.
2.8E-10	4250.	60.
2.5E-10	4225.	60.
2.2E-10	4195.	60.
2.0E-10	4170.	60.
1.88E-10	4140.	60.
1.77E-10	4110.	60.
1.78E-10	4080.	60.
1.80E-10	4030.	120.
1.80E-10	3970.	120.
1.72E-10	3905.	120.
1.8E-10	3860.	120.
2.0E-10	3800.	120.
2.3E-10	3720.	120.
2.65E-10	3665.	120.
2.92E-10	3600.	120.
3.25E-10	3510.	120.
3.5E-10	3475.	120.
3.85E-10	3390.	120.
4.3E-10	3330.	120.
4.9E-10	3270.	120.
5.6E-10	3200.	120.
6.3E-10	3150.	120.

7.05E-10	3085.	120.
7.72E-10	3005.	120.
8.22E-10	2935.	120.
8.65E-10	2890.	120.
9.05E-10	2810.	120.
9.6E-10	2740.	120.
10.0E-10	2685.	120.
11.3E-10	2620.	120.
13.5E-10	2540.	120.
15.5E-10	2480.	120.
17.8E-10	2400.	120.
20.0E-10	2335.	120.
22.5E-10	2270.	120.
24.3E-10	2190.	120.
25.3E-10	2115.	120.
25.2E-10	2040.	120.
24.8E-10	2000.	60.
23.6E-10	1965.	60.
21.3E-10	1880.	120.
18.0E-10	1810.	120.
15.5E-10	1730.	120.
14.1E-10	1660.	120.
13.1E-10	1580.	120.

FOURTH REFREEZE OF RSST9 RUN # F190 2/18/83
SAMPLE THICKNESS=0.37inches (51) DOPED ICE VCH.=1500
FROZEN UNDER CARBON DIOXIDE ATMOSPHERE

83	20.	0.019
0.3E-10	5180.	0.0
0.5E-10	5145.	60.
0.75E-10	5120.	60.
1.2E-10	5100.	60.
2.0E-10	5080.	60.
3.0E-10	5052.	60.
3.6E-10	5025.	60.
5.0E-10	5000.	60.
6.4E-10	4980.	60.
8.0E-10	4955.	60.
10.0E-10	4930.	60.
11.0E-10	4905.	60.
13.3E-10	4885.	60.
14.0E-10	4865.	60.
14.2E-10	4830.	60.
14.0E-10	4805.	60.
13.4E-10	4790.	60.
12.0E-10	4765.	60.
10.0E-10	4730.	60.
9.0E-10	4710.	60.
8.15E-10	4695.	60.
7.9E-10	4660.	60.
7.72E-10	4635.	60.
7.62E-10	4615.	60.
7.55E-10	4600.	60.
7.35E-10	4575.	60.
7.05E-10	4530.	60.
6.5E-10	4515.	60.
5.7E-10	4495.	60.
5.2E-10	4475.	60.
4.8E-10	4430.	60.
4.48E-10	4405.	60.
4.2E-10	4395.	60.
3.95E-10	4360.	60.
3.73E-10	4330.	60.
3.55E-10	4310.	60.
3.37E-10	4290.	60.
3.08E-10	4250.	60.
2.8E-10	4220.	60.
2.62E-10	4200.	60.
2.52E-10	4180.	60.
2.52E-10	4155.	60.
2.55E-10	4120.	60.
2.7E-10	4100.	60.
3.13E-10	4030.	120.
3.78E-10	3980.	120.
4.8E-10	3900.	120.
5.8E-10	3835.	120.
7.0E-10	3785.	120.
8.5E-10	3715.	120.
10.8E-10	3650.	120.
14.5E-10	3600.	120.
24.5E-10	3525.	120.
41.0E-10	3450.	120.
68.0E-10	3400.	120.
88.0E-10	3360.	60.
120.0E-10	3315.	60.
100.0E-10	3295.	60.
83.0E-10	3265.	60.
78.0E-10	3225.	60.

73.2E-10	3180.	120.
72.0E-10	3105.	120.
72.0E-10	3040.	120.
72.3E-10	2980.	120.
73.3E-10	2905.	120.
74.3E-10	2830.	120.
76.0E-10	2780.	120.
78.0E-10	2705.	120.
80.8E-10	2635.	120.
84.0E-10	2580.	120.
89.0E-10	2500.	120.
100.0E-10	2420.	120.
110.0E-10	2245.	300.
115.0E-10	2185.	120.
120.0E-10	2115.	120.
129.0E-10	1990.	180.
131.0E-10	1950.	60.
130.0E-10	1880.	120.
129.0E-10	1800.	120.
124.0E-10	1730.	120.
120.0E-10	1660.	120.
116.0E-10	1580.	120.
112.0E-10	1495.	120.

SAMPLE # RSST10 RUN # F191 2/22/83
SAMPLE THICKNESS=0.375inches (51) PURE ICE VCH.=1500.
FROZEN UNDER NO VACUUM
76 20. 0.019

0.37E-10	5110.	60.
0.60E-10	5090.	60.
0.85E-10	5075.	60.
1.22E-10	5035.	60.
1.80E-10	5020.	60.
2.30E-10	5005.	60.
3.00E-10	4985.	60.
3.90E-10	4970.	60.
5.10E-10	4930.	60.
6.20E-10	4905.	60.
7.90E-10	4890.	60.
9.10E-10	4875.	60.
9.90E-10	4845.	60.
10.5E-10	4815.	60.
11.7E-10	4795.	60.
11.8E-10	4770.	60.
11.5E-10	4730.	60.
11.1E-10	4705.	60.
10.3E-10	4695.	60.
9.5E-10	4675.	60.
9.4E-10	4645.	60.
9.4E-10	4620.	60.
9.43E-10	4600.	60.
9.5E-10	4570.	60.
9.3E-10	4540.	60.
8.98E-10	4520.	60.
8.91E-10	4500.	60.
9.15E-10	4480.	60.
9.5E-10	4435.	60.
10.5E-10	4410.	60.
12.0E-10	4395.	60.
13.0E-10	4375.	60.
14.2E-10	4345.	60.
15.2E-10	4320.	60.
16.2E-10	4295.	60.
17.0E-10	4260.	60.
17.0E-10	4230.	60.
16.3E-10	4205.	60.
15.0E-10	4180.	60.
13.0E-10	4150.	60.
11.0E-10	4120.	60.
9.4E-10	4095.	60.
7.85E-10	4075.	60.
7.3E-10	4030.	60.
6.85E-10	4000.	60.
6.41E-10	3950.	120.
6.31E-10	3890.	120.
6.50E-10	3820.	120.
7.50E-10	3750.	120.
8.12E-10	3695.	120.
8.70E-10	3620.	120.
9.20E-10	3570.	120.
10.6E-10	3495.	120.
12.5E-10	3420.	120.
13.8E-10	3375.	120.
14.2E-10	3300.	120.
14.1E-10	3235.	120.
13.9E-10	3185.	120.
13.8E-10	3100.	120.
13.3E-10	3035.	120.

13.1E-10	2980.	120.
13.2E-10	2905.	120.
13.5E-10	2845.	120.
13.9E-10	2785.	120.
14.1E-10	2720.	120.
15.0E-10	2655.	120.
15.8E-10	2575.	120.
16.7E-10	2500.	120.
16.8E-10	2425.	120.
16.7E-10	2365.	120.
16.2E-10	2300.	120.
15.2E-10	2210.	120.
13.9E-10	2135.	120.
12.3E-10	2065.	120.
10.8E-10	1995.	120.
10.0E-10	1960.	60.

FIRST REFREEZE OF RSST10 RUN # F192 2/26/83
SAMPLE THICKNESS=0.37inches (51) PURE ICE VCH.=1500
FROZEN UNDER A 12 PSI VACUUM

83	20.	0.019
0.53E-10	5165.	0.0
0.81E-10	5130.	60.
1.20E-10	5105.	60.
1.90E-10	5085.	60.
2.90E-10	5060.	60.
4.10E-10	5030.	60.
5.60E-10	5005.	60.
7.40E-10	4985.	60.
9.50E-10	4966.	60.
10.5E-10	4950.	60.
12.0E-10	4920.	60.
13.8E-10	4895.	60.
15.0E-10	4875.	60.
15.7E-10	4850.	60.
16.3E-10	4824.	60.
16.8E-10	4798.	60.
16.6E-10	4778.	60.
16.1E-10	4748.	60.
15.6E-10	4720.	60.
15.0E-10	4700.	60.
14.6E-10	4676.	60.
14.7E-10	4645.	60.
14.9E-10	4620.	60.
15.1E-10	4600.	60.
15.3E-10	4580.	60.
15.9E-10	4555.	60.
16.2E-10	4530.	60.
16.1E-10	4505.	60.
15.6E-10	4485.	60.
14.9E-10	4450.	60.
13.7E-10	4420.	60.
12.0E-10	4400.	60.
9.90E-10	4380.	60.
8.20E-10	4350.	60.
7.00E-10	4320.	60.
6.10E-10	4300.	60.
5.50E-10	4275.	60.
5.00E-10	4235.	60.
4.52E-10	4210.	60.
4.22E-10	4180.	60.
3.95E-10	4160.	60.
3.80E-10	4130.	60.
3.80E-10	4100.	60.
3.83E-10	4075.	60.
4.02E-10	4050.	60.
4.12E-10	4015.	60.
4.30E-10	3985.	60.
4.50E-10	3948.	60.
4.60E-10	3910.	60.
4.69E-10	3885.	60.
4.78E-10	3850.	60.
4.97E-10	3825.	60.
5.25E-10	3795.	60.
5.50E-10	3770.	60.
5.90E-10	3725.	60.
6.18E-10	3700.	60.
6.37E-10	3670.	60.
7.35E-10	3605.	120.
10.0E-10	3525.	120.
13.0E-10	3470.	120.

16.0E-10	3405.	120.
19.5E-10	3330.	120.
19.7E-10	3270.	120.
18.0E-10	3210.	120.
17.2E-10	3155.	120.
17.25E-10	3085.	120.
17.35E-10	3030.	120.
17.9E-10	2960.	120.
18.45E-10	2890.	120.
18.8E-10	2825.	120.
19.0E-10	2700.	240.
19.3E-10	2550.	240.
20.3E-10	2400.	240.
21.7E-10	2280.	240.
25.0E-10	2125.	240.
30.2E-10	1980.	240.
32.7E-10	1890.	120.
33.7E-10	1830.	60.
34.3E-10	1800.	60.
34.5E-10	1770.	60.
34.5E-10	1735.	60.
34.3E-10	1700.	60.
34.1E-10	1670.	60.

FIRST REFREEZE OF RSST10 RUN # F193 2/27/83
SAMPLE THICKNESS=0.37inches (51) PURE ICE VCH.=500
SAMPLE REFROZEN UNDER 12 PSI VACUUM

83	20.	0.019
0.40E-10	5100.	0.0
0.70E-10	5080.	60.
0.90E-10	5050.	60.
1.30E-10	5030.	60.
1.60E-10	5010.	60.
2.25E-10	4990.	60.
2.95E-10	4970.	60.
3.75E-10	4940.	60.
4.30E-10	4915.	60.
4.90E-10	4895.	60.
5.50E-10	4875.	60.
6.10E-10	4855.	60.
6.60E-10	4825.	60.
7.02E-10	4800.	60.
7.08E-10	4780.	60.
6.80E-10	4735.	60.
6.30E-10	4715.	60.
5.80E-10	4695.	60.
5.38E-10	4675.	60.
5.20E-10	4648.	60.
5.09E-10	4620.	60.
5.12E-10	4600.	60.
5.50E-10	4575.	60.
5.77E-10	4545.	60.
5.68E-10	4520.	60.
5.10E-10	4500.	60.
4.58E-10	4480.	60.
4.10E-10	4455.	60.
3.60E-10	4420.	60.
3.15E-10	4400.	60.
2.40E-10	4380.	60.
1.97E-10	4350.	60.
1.60E-10	4330.	60.
1.38E-10	4300.	60.
1.20E-10	4265.	60.
1.07E-10	4230.	60.
1.00E-10	4205.	60.
0.92E-10	4180.	60.
0.83E-10	4150.	60.
0.81E-10	4125.	60.
0.79E-10	4100.	60.
0.75E-10	4075.	60.
0.72E-10	4035.	60.
0.71E-10	4005.	60.
0.70E-10	3975.	60.
0.70E-10	3950.	60.
0.70E-10	3912.	60.
0.71E-10	3880.	60.
0.75E-10	3825.	120.
0.82E-10	3765.	120.
0.94E-10	3690.	120.
1.02E-10	3625.	120.
1.04E-10	3565.	120.
1.30E-10	3496.	120.
1.48E-10	3420.	120.
1.63E-10	3370.	120.
1.85E-10	3300.	120.
2.08E-10	3235.	120.
2.30E-10	3180.	120.
2.52E-10	3105.	120.

2.83E-10	3050.	120.
3.13E-10	2990.	120.
3.43E-10	2920.	120.
3.80E-10	2850.	120.
4.25E-10	2785.	120.
4.72E-10	2720.	120.
5.28E-10	2665.	120.
5.95E-10	2595.	120.
6.75E-10	2515.	120.
7.65E-10	2440.	120.
8.43E-10	2380.	120.
9.20E-10	2305.	120.
10.0E-10	2220.	120.
10.6E-10	2160.	120.
11.3E-10	2080.	120.
13.8E-10	1920.	240.
14.0E-10	1900.	60.
14.1E-10	1860.	60.
14.1E-10	1820.	60.
14.15E-10	1780.	60.
14.15E-10	1735.	60.
14.15E-10	1700.	60.
14.15E-10	1670.	60.

FIRST REFREEZE OF RSST10 RUN # F194 3/1/83
SAMPLE THICKNESS=0.37inches (51) PURE ICE VCH.=1000
FROZEN UNDER A 12 PSI VACUUM

83	20.	0.019
0.51E-10	5155.	0.0
0.75E-10	5130.	60.
1.07E-10	5105.	60.
1.85E-10	5085.	60.
2.55E-10	5060.	60.
3.70E-10	5030.	60.
5.10E-10	5009.	60.
6.10E-10	4990.	60.
7.15E-10	4975.	60.
8.30E-10	4950.	60.
9.97E-10	4925.	60.
10.9E-10	4900.	60.
11.6E-10	4875.	60.
11.9E-10	4845.	60.
11.9E-10	4820.	60.
11.7E-10	4800.	60.
10.5E-10	4775.	60.
9.30E-10	4740.	60.
8.90E-10	4720.	60.
8.23E-10	4700.	60.
8.02E-10	4675.	60.
7.98E-10	4632.	60.
8.01E-10	4615.	60.
8.21E-10	4597.	60.
8.73E-10	4577.	60.
9.26E-10	4558.	60.
9.31E-10	4530.	60.
9.18E-10	4503.	60.
8.65E-10	4485.	60.
7.70E-10	4457.	60.
6.70E-10	4430.	60.
5.85E-10	4400.	60.
5.23E-10	4373.	60.
4.33E-10	4340.	60.
3.48E-10	4316.	60.
3.10E-10	4293.	60.
2.74E-10	4263.	60.
2.45E-10	4233.	60.
2.24E-10	4205.	60.
2.06E-10	4182.	60.
1.92E-10	4152.	60.
1.80E-10	4129.	60.
1.70E-10	4000.	60.
1.65E-10	4072.	60.
1.61E-10	4042.	60.
1.63E-10	4015.	60.
1.69E-10	3985.	60.
1.79E-10	3960.	60.
2.03E-10	3885.	120.
2.32E-10	3805.	120.
2.58E-10	3730.	120.
2.87E-10	3675.	120.
3.20E-10	3615.	120.
3.45E-10	3560.	120.
3.86E-10	3490.	120.
4.25E-10	3425.	120.
4.70E-10	3362.	120.
5.08E-10	3295.	120.
5.38E-10	3225.	120.
5.72E-10	3170.	120.

6.05E-10	3110.	120.
6.45E-10	3050.	120.
7.00E-10	2980.	120.
7.60E-10	2910.	120.
8.38E-10	2850.	120.
9.40E-10	2780.	120.
10.0E-10	2710.	120.
11.0E-10	2643.	120.
12.0E-10	2578.	120.
13.1E-10	2498.	120.
14.3E-10	2430.	120.
15.7E-10	2375.	120.
16.4E-10	2300.	120.
17.9E-10	2220.	120.
19.0E-10	2140.	120.
20.7E-10	1995.	240.
21.3E-10	1915.	120.
21.9E-10	1875.	60.
22.0E-10	1830.	60.
22.0E-10	1760.	120.
21.8E-10	1725.	60.
21.2E-10	1685.	60.
20.2E-10	1600.	120.

THIRD REFREEZE OF RSST10 RUN # F196 3/8/83
SAMPLE THICKNESS=0.37inches (51) PURE ICE VCH.=1500
FROZEN UNDER A 12 PSI VACUUM

76	20.	0.019
0.75E-10	5185.	0.0
1.05E-10	5163.	60.
1.83E-10	5127.	60.
2.70E-10	5105.	60.
4.30E-10	5080.	60.
5.60E-10	5052.	60.
7.30E-10	5028.	60.
8.50E-10	5005.	60.
10.0E-10	4985.	60.
12.7E-10	4965.	60.
15.5E-10	4940.	60.
17.3E-10	4915.	60.
18.3E-10	4890.	60.
18.2E-10	4868.	60.
17.3E-10	4840.	60.
15.7E-10	4815.	60.
13.7E-10	4790.	60.
11.7E-10	4765.	60.
9.7E-10	4740.	60.
8.8E-10	4720.	60.
7.8E-10	4700.	60.
6.98E-10	4676.	60.
6.88E-10	4645.	60.
6.92E-10	4620.	60.
7.06E-10	4600.	60.
7.35E-10	4580.	60.
7.62E-10	4548.	60.
7.98E-10	4523.	60.
8.35E-10	4505.	60.
8.76E-10	4480.	60.
9.28E-10	4452.	60.
9.60E-10	4428.	60.
9.77E-10	4402.	60.
9.82E-10	4380.	60.
9.83E-10	4357.	60.
9.82E-10	4330.	60.
9.78E-10	4302.	60.
9.62E-10	4276.	60.
9.25E-10	4240.	60.
8.78E-10	4215.	60.
8.38E-10	4186.	60.
8.05E-10	4162.	60.
7.77E-10	4130.	60.
7.55E-10	4105.	60.
7.32E-10	4080.	60.
7.15E-10	4050.	60.
7.00E-10	4023.	60.
6.89E-10	4000.	60.
6.80E-10	3968.	60.
6.72E-10	3930.	60.
6.58E-10	3855.	120.
6.52E-10	3790.	120.
6.63E-10	3725.	120.
7.15E-10	3670.	120.
8.10E-10	3610.	120.
9.50E-10	3540.	120.
11.2E-10	3470.	120.
12.8E-10	3390.	120.
13.0E-10	3330.	120.
11.9E-10	3270.	120.

11.2E-10	3215.	120.
10.8E-10	3157.	120.
10.2E-10	3090.	120.
10.3E-10	3025.	120.
10.8E-10	2960.	120.
11.1E-10	2890.	120.
11.5E-10	2820.	120.
11.9E-10	2750.	120.
12.1E-10	2690.	120.
12.5E-10	2625.	120.
13.1E-10	2568.	120.
14.5E-10	2485.	120.
15.8E-10	2405.	120.
16.9E-10	2330.	120.
19.7E-10	2200.	240.
21.8E-10	2035.	240.

SAMPLE # RSST11 RUN # F198 3/14/83
SAMPLE THICKNESS=0.37inches (51) PURE ICE VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.52E-10	5120.	0.0
0.76E-10	5095.	60.
1.10E-10	5070.	60.
1.48E-10	5045.	60.
1.94E-10	5020.	60.
2.40E-10	4997.	60.
3.15E-10	4972.	60.
4.00E-10	4945.	60.
4.90E-10	4920.	60.
5.75E-10	4898.	60.
6.53E-10	4875.	60.
7.35E-10	4849.	60.
8.38E-10	4822.	60.
9.00E-10	4790.	60.
9.25E-10	4770.	60.
9.28E-10	4748.	60.
9.07E-10	4722.	60.
8.68E-10	4700.	60.
8.08E-10	4680.	60.
7.62E-10	4656.	60.
7.45E-10	4630.	60.
7.88E-10	4607.	60.
8.53E-10	4580.	60.
9.35E-10	4552.	60.
9.90E-10	4530.	60.
10.6E-10	4505.	60.
12.2E-10	4480.	60.
13.7E-10	4453.	60.
15.5E-10	4425.	60.
17.0E-10	4400.	60.
18.1E-10	4378.	60.
19.2E-10	4350.	60.
20.3E-10	4325.	60.
21.1E-10	4300.	60.
21.8E-10	4273.	60.
21.9E-10	4240.	60.
21.2E-10	4215.	60.
20.2E-10	4190.	60.
18.9E-10	4167.	60.
17.7E-10	4132.	60.
16.7E-10	4104.	60.
15.4E-10	4076.	60.
14.9E-10	4042.	60.
14.0E-10	4018.	60.
13.3E-10	3990.	60.
12.9E-10	3960.	60.
12.2E-10	3930.	60.
11.8E-10	3850.	120.
10.9E-10	3790.	120.
10.2E-10	3725.	120.
9.80E-10	3670.	120.
9.90E-10	3605.	120.
10.8E-10	3520.	120.
12.1E-10	3465.	120.
13.8E-10	3390.	120.
14.6E-10	3325.	120.
15.6E-10	3260.	120.
16.0E-10	3200.	120.
16.2E-10	3140.	120.
16.5E-10	3080.	120.

17.0E-10	3015.	120.
17.6E-10	2935.	120.
18.1E-10	2880.	120.
18.3E-10	2815.	120.
18.5E-10	2748.	120.
18.5E-10	2688.	120.
19.1E-10	2620.	120.
21.5E-10	2550.	120.
24.8E-10	2480.	120.
29.0E-10	2400.	120.
32.4E-10	2330.	120.
37.0E-10	2260.	120.
40.8E-10	2190.	120.
44.0E-10	2115.	120.
45.3E-10	2077.	60.
47.0E-10	2030.	60.
50.7E-10	1950.	120.
50.7E-10	1920.	60.
49.9E-10	1890.	60.
46.3E-10	1810.	120.
41.5E-10	1730.	120.
36.0E-10	1670.	120.
30.5E-10	1580.	120.

THIRD REFREEZE OF RSST11 RUN # F201 3/24/83
SAMPE THICKNESS=0.37inches (51) PURE ICE VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.65E-10	5205.	0.0
0.93E-10	5187.	60.
1.30E-10	5165.	60.
2.00E-10	5132.	60.
2.75E-10	5110.	60.
3.90E-10	5090.	60.
5.05E-10	5070.	60.
6.20E-10	5050.	60.
7.60E-10	5025.	60.
9.00E-10	5005.	60.
10.2E-10	4987.	60.
11.3E-10	4968.	60.
12.5E-10	4943.	60.
14.0E-10	4917.	60.
14.9E-10	4893.	60.
15.1E-10	4871.	60.
15.0E-10	4846.	60.
14.2E-10	4815.	60.
13.2E-10	4792.	60.
12.0E-10	4768.	60.
10.6E-10	4740.	60.
9.60E-10	4720.	60.
8.90E-10	4700.	60.
8.27E-10	4675.	60.
7.73E-10	4642.	60.
7.48E-10	4615.	60.
7.53E-10	4592.	60.
8.20E-10	4570.	60.
9.05E-10	4546.	60.
9.70E-10	4520.	60.
10.4E-10	4500.	60.
10.8E-10	4480.	60.
11.2E-10	4452.	60.
11.8E-10	4423.	60.
12.0E-10	4400.	60.
11.9E-10	4370.	60.
11.3E-10	4340.	60.
10.2E-10	4313.	60.
9.20E-10	4280.	60.
8.20E-10	4250.	60.
8.00E-10	4223.	60.
7.55E-10	4200.	60.
7.00E-10	4177.	60.
6.55E-10	4150.	60.
6.20E-10	4122.	60.
5.83E-10	4093.	60.
5.58E-10	4060.	60.
5.32E-10	4031.	60.
5.12E-10	4003.	60.
4.95E-10	3980.	60.
4.63E-10	3900.	120.
4.32E-10	3830.	120.
4.17E-10	3780.	120.
4.05E-10	3710.	120.
4.08E-10	3650.	120.
4.19E-10	3595.	120.
4.48E-10	3510.	120.
4.78E-10	3460.	120.
5.20E-10	3395.	120.
5.63E-10	3320.	120.

6.12E-10	3260.	120.
6.62E-10	3210.	120.
7.10E-10	3140.	120.
7.50E-10	3070.	120.
7.93E-10	3010.	120.
8.37E-10	2950.	120.
8.85E-10	2880.	120.
9.46E-10	2800.	120.
10.0E-10	2735.	120.
10.5E-10	2680.	120.
11.1E-10	2610.	120.
12.3E-10	2535.	120.
15.8E-10	2390.	240.
17.9E-10	2250.	240.
18.7E-10	2190.	120
19.5E-10	2110.	120.
20.5E-10	2030.	120.
22.8E-10	1970.	120.
24.1E-10	1875.	120.
25.1E-10	1800.	120.
25.2E-10	1720.	120.
24.9E-10	1650.	120.
23.9E-10	1570.	120.

FIFTH REFREEZE OF RSST11 RUN # F203 3/30/83

SAMPLE THICKNESS=0.37inches (51) PURE ICE VCH.=1500

FROZEN UNDER CARBON DIOXIDE ATMOSPHERE ?

83	20.	0.019
0.34E-10	5110.	0.0
0.55E-10	5087.	60.
0.64E-10	5060.	60.
0.87E-10	5030.	60.
1.00E-10	5010.	60.
1.20E-10	4990.	60.
1.50E-10	4965.	60.
1.86E-10	4940.	60.
2.18E-10	4915.	60.
2.54E-10	4890.	60.
3.05E-10	4870.	60.
3.60E-10	4845.	60.
4.05E-10	4820.	60.
4.70E-10	4795.	60.
5.35E-10	4768.	60.
6.22E-10	4740.	60.
6.68E-10	4715.	60.
6.79E-10	4695.	60.
6.80E-10	4675.	60.
6.79E-10	4648.	60.
6.72E-10	4620.	60.
6.60E-10	4600.	60.
6.42E-10	4573.	60.
6.10E-10	4550.	60.
5.44E-10	4525.	60.
4.96E-10	4500.	60.
4.65E-10	4480.	60.
4.45E-10	4453.	60.
4.35E-10	4425.	60.
4.28E-10	4400.	60.
4.28E-10	4372.	60.
4.38E-10	4340.	60.
4.70E-10	4313.	60.
5.20E-10	4288.	60.
5.80E-10	4260.	60.
6.60E-10	4230.	60.
7.00E-10	4200.	60.
7.28E-10	4172.	60.
7.30E-10	4148.	60.
7.28E-10	4120.	60.
7.18E-10	4095.	60.
7.03E-10	4070.	60.
7.02E-10	4040.	60.
7.28E-10	4010.	60.
7.98E-10	3988.	60.
10.0E-10	3910.	120.
11.2E-10	3850.	120.
12.9E-10	3790.	120.
14.6E-10	3710.	120.
16.7E-10	3660.	120.
18.9E-10	3600.	120.
20.8E-10	3530.	120.
23.0E-10	3462.	120.
25.7E-10	3392.	120.
28.0E-10	3340.	120.
30.1E-10	3290.	120.
32.3E-10	3220.	120.
34.7E-10	3170.	120.
36.4E-10	3100.	120.
38.8E-10	3040.	120.

41.3E-10	2985.	120.
46.0E-10	2900.	120.
53.0E-10	2830.	120.
61.0E-10	2770.	120.
69.0E-10	2700.	120.
80.0E-10	2630.	120.
91.0E-10	2570.	120.
100.E-10	2500.	120.
113.E-10	2430.	120.
130.E-10	2360.	120.
145.E-10	2290.	120.
170.E-10	2210.	120.
183.E-10	2173.	60.
195.E-10	2131.	60.
202.E-10	2100.	60.
210.E-10	2061.	60.
230.E-10	1980.	120.
250.E-10	1900.	120.
268.E-10	1825.	120.
273.E-10	1760.	120.
272.E-10	1675.	120.
271.E-10	1590.	120.
268.E-10	1520.	120.

THIRD REFREEZE OF RSST12 RUN # F204 4/6/83
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.30E-10	5150.	0.0
0.40E-10	5128.	60.
0.70E-10	5105.	60.
1.10E-10	5078.	60.
1.70E-10	5052.	60.
2.10E-10	5025.	60.
2.90E-10	5005.	60.
3.80E-10	4982.	60.
4.90E-10	4960.	60.
6.00E-10	4935.	60.
7.20E-10	4913.	60.
9.20E-10	4890.	60.
10.0E-10	4863.	60.
11.1E-10	4833.	60.
12.2E-10	4808.	60.
13.0E-10	4785.	60.
13.0E-10	4765.	60.
12.8E-10	4740.	60.
12.1E-10	4715.	60.
12.0E-10	4692.	60.
11.8E-10	4670.	60.
11.2E-10	4645.	60.
11.0E-10	4620.	60.
10.9E-10	4600.	60.
11.1E-10	4575.	60.
11.8E-10	4540.	60.
12.1E-10	4515.	60.
13.0E-10	4490.	60.
14.5E-10	4465.	60.
15.7E-10	4436.	60.
16.0E-10	4408.	60.
16.1E-10	4385.	60.
16.0E-10	4360.	60.
15.0E-10	4330.	60.
13.8E-10	4305.	60.
12.5E-10	4278.	60.
11.0E-10	4250.	60.
9.50E-10	4220.	60.
8.00E-10	4190.	60.
6.90E-10	4160.	60.
6.00E-10	4135.	60.
5.48E-10	4110.	60.
5.11E-10	4090.	60.
4.99E-10	4045.	60.
4.92E-10	4015.	60.
4.90E-10	3985.	60.
4.92E-10	3957.	60.
5.03E-10	3925.	60.
5.14E-10	3890.	60.
5.27E-10	3850.	60.
5.55E-10	3790.	120.
5.82E-10	3730.	120.
6.30E-10	3670.	120.
6.95E-10	3600.	120.
8.18E-10	3530.	120.
10.0E-10	3465.	120.
12.1E-10	3395.	120.
14.1E-10	3330.	120.
15.1E-10	3270.	120.
15.7E-10	3205.	120.

15.9E-10	3145.	120.
16.1E-10	3080.	120.
17.0E-10	3010.	120.
17.8E-10	2940.	120.
18.0E-10	2880.	120.
18.1E-10	2810.	120.
18.1E-10	2745.	120.
18.1E-10	2685.	120.
18.0E-10	2615.	120.
17.9E-10	2550.	120.
17.8E-10	2480.	120.
17.2E-10	2405.	120.
16.2E-10	2330.	120.
15.0E-10	2265.	120.
14.0E-10	2200.	120.
13.1E-10	2120.	120.
12.3E-10	2035.	120.
12.1E-10	1950.	120.
11.8E-10	1880.	120.
11.3E-10	1800.	120.
11.0E-10	1730.	120.
10.9E-10	1670.	120.
10.8E-10	1600.	120.

FOURTH REFREEZE OF RSST12 RUN # F205 4/19/83
SAMPLE THICKNESS=.37inches PURE ICE VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.40E-10	5180.	0.0
0.49E-10	5160.	60.
0.63E-10	5140.	60.
0.78E-10	5118.	60.
1.15E-10	5093.	60.
1.48E-10	5071.	60.
2.00E-10	5045.	60.
2.70E-10	5020.	60.
3.20E-10	5000.	60.
4.00E-10	4980.	60.
5.00E-10	4955.	60.
6.70E-10	4929.	60.
8.20E-10	4903.	60.
9.80E-10	4880.	60.
11.0E-10	4855.	60.
12.9E-10	4830.	60.
14.5E-10	4803.	60.
15.9E-10	4780.	60.
16.8E-10	4755.	60.
17.1E-10	4730.	60.
16.9E-10	4703.	60.
16.2E-10	4680.	60.
15.3E-10	4653.	60.
14.5E-10	4628.	60.
14.1E-10	4600.	60.
14.0E-10	4575.	60.
14.1E-10	4550.	60.
14.2E-10	4525.	60.
14.6E-10	4500.	60.
15.0E-10	4475.	60.
16.0E-10	4450.	60.
17.4E-10	4425.	60.
17.9E-10	4400.	60.
17.7E-10	4375.	60.
16.8E-10	4350.	60.
15.5E-10	4325.	60.
13.7E-10	4300.	60.
12.0E-10	4275.	60.
10.3E-10	4250.	60.
8.60E-10	4205.	60.
7.30E-10	4178.	60.
6.50E-10	4150.	60.
6.10E-10	4120.	60.
5.83E-10	4090.	60.
5.63E-10	4060.	60.
5.51E-10	4030.	60.
5.52E-10	4000.	60.
5.85E-10	3950.	120.
6.34E-10	3885.	120.
6.75E-10	3820.	120.
7.20E-10	3753.	120.
7.77E-10	3695.	120.
8.65E-10	3625.	120.
9.98E-10	3560.	120.
11.7E-10	3490.	120.
13.8E-10	3420.	120.
15.9E-10	3365.	120.
18.1E-10	3295.	120.
19.8E-10	3230.	120.
21.0E-10	3165.	120.

21.8E-10	3100.	120.
22.1E-10	3030.	120.
22.9E-10	2975.	120.
23.7E-10	2905.	120.
24.2E-10	2830.	120.
24.3E-10	2770.	120.
24.2E-10	2705.	120.
24.1E-10	2630.	120.
23.9E-10	2570.	120.
23.7E-10	2500.	120.
23.2E-10	2425.	120.
23.0E-10	2350.	120.
22.5E-10	2280.	120.
22.0E-10	2200.	120.
21.2E-10	2125.	120.
20.0E-10	2050.	120.
18.9E-10	1980.	120.
17.8E-10	1905.	120.
16.6E-10	1825.	120.
16.0E-10	1750.	120.
16.0E-10	1675.	120.
16.2E-10	1595.	120.
17.1E-10	1500.	120.

SIXTH REFREEZE OF RSST12 RUN # F207 4/16/83
SAMPLE THICKNESS=.37inches DOPED ICE VCH.=1500
FROZEN UNDER CARBON DIOXIDE ATMOSPHERE

83	20.	0.019
0.39E-10	5130.	0.0
0.63E-10	5105.	60.
0.90E-10	5083.	60.
1.20E-10	5058.	60.
1.50E-10	5032.	60.
1.80E-10	5010.	60.
2.25E-10	4990.	60.
2.80E-10	4970.	60.
3.20E-10	4947.	60.
3.65E-10	4920.	60.
4.02E-10	4900.	60.
4.50E-10	4880.	60.
4.90E-10	4853.	60.
5.17E-10	4825.	60.
5.27E-10	4800.	60.
5.20E-10	4775.	60.
5.01E-10	4750.	60.
4.72E-10	4725.	60.
4.36E-10	4700.	60.
4.00E-10	4675.	60.
3.73E-10	4650.	60.
3.52E-10	4625.	60.
3.39E-10	4600.	60.
3.30E-10	4575.	60.
3.20E-10	4550.	60.
3.03E-10	4525.	60.
2.89E-10	4500.	60.
2.83E-10	4475.	60.
2.86E-10	4450.	60.
2.93E-10	4425.	60.
3.02E-10	4400.	60.
3.10E-10	4375.	60.
3.18E-10	4350.	60.
3.26E-10	4325.	60.
3.31E-10	4300.	60.
3.32E-10	4275.	60.
3.35E-10	4250.	60.
3.35E-10	4225.	60.
3.31E-10	4200.	60.
3.28E-10	4175.	60.
3.29E-10	4140.	60.
3.31E-10	4110.	60.
3.38E-10	4080.	60.
3.50E-10	4050.	60.
3.68E-10	4020.	60.
3.90E-10	3988.	60.
4.20E-10	3953.	60.
4.55E-10	3920.	60.
5.00E-10	3890.	60.
5.68E-10	3825.	120.
6.12E-10	3760.	120.
6.43E-10	3700.	120.
6.80E-10	3630.	120.
7.50E-10	3570.	120.
9.30E-10	3495.	120.
10.2E-10	3425.	120.
11.0E-10	3365.	120.
12.1E-10	3295.	120.
14.2E-10	3230.	120.
17.0E-10	3170.	120.

20.6E-10	3105.	120.
24.5E-10	3040.	120.
31.0E-10	2970.	120.
39.0E-10	2900.	120.
47.3E-10	2835.	120.
57.8E-10	2770.	120.
65.7E-10	2700.	120.
80.5E-10	2635.	120.
93.0E-10	2570.	120.
108.E-10	2500.	120.
129.E-10	2425.	120.
148.E-10	2365.	120.
163.E-10	2295.	120.
188.E-10	2220.	120.
199.E-10	2140.	120.
210.E-10	2065.	120.
225.E-10	1990.	120.
230.E-10	1920.	120.
227.E-10	1835.	120.
220.E-10	1770.	120.
215.E-10	1700.	120.
207.E-10	1620.	120.
200.E-10	1535.	120.

SAMPLE # RTF4 RUN # F208 4/21/83
SAMPLE THICKNESS=.37inches PURE ICE VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.84E-10	5190.	0.0
1.00E-10	5160.	60.
1.40E-10	5135.	60.
1.90E-10	5110.	60.
2.80E-10	5090.	60.
3.60E-10	5065.	60.
4.18E-10	5040.	60.
4.60E-10	5015.	60.
4.75E-10	4995.	60.
4.75E-10	4975.	60.
4.63E-10	4950.	60.
4.30E-10	4925.	60.
3.80E-10	4900.	60.
3.10E-10	4875.	60.
2.20E-10	4850.	60.
1.67E-10	4825.	60.
1.25E-10	4800.	60.
0.75E-10	4775.	60.
0.42E-10	4750.	60.
0.37E-10	4725.	60.
0.32E-10	4700.	60.
0.31E-10	4675.	60.
0.29E-10	4650.	60.
0.28E-10	4625.	60.
0.26E-10	4600.	60.
0.23E-10	4575.	60.
0.21E-10	4550.	60.
0.18E-10	4525.	60.
0.10E-10	4500.	60.
0.00E-10	4475.	60.
0.00E-10	4450.	60.
0.00E-10	4425.	60.
0.00E-10	4400.	60.
0.00E-10	4375.	60.
0.00E-10	4350.	60.
0.00E-10	4325.	60.
0.00E-10	4300.	60.
0.00E-10	4275.	60.
0.00E-10	4250.	60.
0.00E-10	4225.	60.
0.00E-10	4200.	60.
0.00E-10	4175.	60.
0.00E-10	4150.	60.
0.00E-10	4120.	60.
0.00E-10	4090.	60.
0.00E-10	4060.	60.
0.00E-10	4030.	60.
0.00E-10	4000.	60.
0.00E-10	3960.	60.
0.00E-10	3930.	60.
0.00E-10	3870.	120.
0.00E-10	3800.	120.
0.00E-10	3730.	120.
0.00E-10	3600.	240.
0.00E-10	3530.	120.
0.00E-10	3470.	120.
0.00E-10	3400.	120.
0.00E-10	3330.	120.
0.00E-10	3270.	120.
0.00E-10	3210.	120.

0.00E-10	3150.	120.
0.00E-10	3080.	120.
0.00E-10	3010.	120.
0.05E-10	2950.	120.
0.15E-10	2890.	120.
0.30E-10	2820.	120.
0.48E-10	2760.	120.
0.63E-10	2695.	120.
0.98E-10	2620.	120.
1.38E-10	2560.	120.
1.95E-10	2490.	120.
2.63E-10	2420.	120.
3.39E-10	2350.	120.
4.00E-10	2280.	120.
4.38E-10	2200.	120.
4.32E-10	2120.	120.
3.82E-10	2050.	120.
3.25E-10	1980.	120.
2.55E-10	1900.	120.
1.93E-10	1820.	120.
1.57E-10	1740.	120.
1.32E-10	1660.	120.
1.20E-10	1590.	120.

FIRST REFREEZE OF RTF4 | RUN # F209 | 4/24/83
SAMPLE THICKNESS=0.37inches | PURE ICE | VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.75E-10	5165.	0.0
1.15E-10	5140.	60.
1.93E-10	5115.	60.
2.85E-10	5090.	60.
3.90E-10	5065.	60.
4.90E-10	5037.	60.
5.90E-10	5010.	60.
6.78E-10	4983.	60.
6.99E-10	4957.	60.
6.92E-10	4930.	60.
6.47E-10	4900.	60.
5.60E-10	4875.	60.
4.50E-10	4850.	60.
3.65E-10	4825.	60.
3.00E-10	4800.	60.
2.10E-10	4775.	60.
1.60E-10	4750.	60.
1.03E-10	4725.	60.
0.63E-10	4700.	60.
0.31E-10	4675.	60.
0.17E-10	4650.	60.
0.03E-10	4625.	60.
0.00E-10	4600.	60.
0.00E-10	4575.	60.
0.00E-10	4550.	60.
0.00E-10	4525.	60.
0.00E-10	4500.	60.
0.00E-10	4475.	60.
0.00E-10	4450.	60.
0.00E-10	4425.	60.
0.00E-10	4400.	60.
0.00E-10	4375.	60.
0.00E-10	4350.	60.
0.00E-10	4325.	60.
0.00E-10	4300.	60.
0.00E-10	4275.	60.
0.00E-10	4250.	60.
0.00E-10	4220.	60.
0.00E-10	4290.	60.
0.00E-10	4160.	60.
0.00E-10	4130.	60.
0.00E-10	4100.	60.
0.00E-10	4070.	60.
0.00E-10	4040.	60.
0.00E-10	4010.	60.
0.00E-10	3980.	60.
0.00E-10	3950.	60.
0.00E-10	3920.	60.
0.00E-10	3890.	60.
0.00E-10	3860.	60.
0.00E-10	3800.	120.
0.00E-10	3730.	120.
0.00E-10	3660.	120.
0.00E-10	3600.	120.
0.00E-10	3535.	120.
0.03E-10	3475.	120.
0.10E-10	3405.	120.
0.12E-10	3345.	120.
0.10E-10	3285.	120.
0.02E-10	3220.	120.

0.00E-10	3165.	120.
0.00E-10	3100.	120.
0.00E-10	3030.	120.
0.02E-10	2970.	120.
0.09E-10	2900.	120.
0.12E-10	2835.	120.
0.19E-10	2770.	120.
0.29E-10	2705.	120.
0.39E-10	2630.	120.
0.53E-10	2565.	120.
0.77E-10	2500.	120.
1.08E-10	2430.	120.
1.32E-10	2370.	120.
1.70E-10	2300.	120.
2.13E-10	2225.	120.
2.60E-10	2150.	120.
3.18E-10	2075.	120.
4.10E-10	2000.	120.
6.15E-10	1850.	240.
7.50E-10	1775.	120.
9.15E-10	1700.	120.
10.7E-10	1620.	120.
13.0E-10	1540.	120.

SECOND REFREEZE OF RTF4 RUN # F210 4/27/83
SAMPLE THICKNESS=0.37 inches PURE ICE VCH.=1500
FROZEN UNDER A 11 PSI VACUUM

83	20.	0.019
0.65E-10	5170.	0.0
0.73E-10	5150.	60.
1.00E-10	5125.	60.
1.70E-10	5100.	60.
2.30E-10	5075.	60.
3.45E-10	5050.	60.
4.40E-10	5025.	60.
5.40E-10	5000.	60.
6.53E-10	4975.	60.
7.32E-10	4950.	60.
7.90E-10	4925.	60.
7.90E-10	4900.	60.
7.00E-10	4875.	60.
5.70E-10	4850.	60.
4.95E-10	4825.	60.
3.75E-10	4800.	60.
2.60E-10	4775.	60.
1.90E-10	4750.	60.
1.26E-10	4725.	60.
0.77E-10	4700.	60.
0.47E-10	4675.	60.
0.28E-10	4650.	60.
0.15E-10	4625.	60.
0.00E-10	4600.	60.
0.00E-10	4575.	60.
0.00E-10	4550.	60.
0.00E-10	4525.	60.
0.00E-10	4500.	60.
0.00E-10	4475.	60.
0.00E-10	4450.	60.
0.00E-10	4425.	60.
0.00E-10	4400.	60.
0.00E-10	4375.	60.
0.00E-10	4350.	60.
0.00E-10	4325.	60.
0.00E-10	4300.	60.
0.00E-10	4275.	60.
0.00E-10	4250.	60.
0.00E-10	4225.	60.
0.00E-10	4200.	60.
0.00E-10	4135.	120.
0.00E-10	4070.	120.
0.00E-10	4005.	120.
0.00E-10	3940.	120.
0.00E-10	3880.	120.
0.00E-10	3820.	120.
0.00E-10	3760.	120.
0.00E-10	3700.	120.
0.00E-10	3640.	120.
0.00E-10	3580.	120.
0.00E-10	3520.	120.
0.00E-10	3460.	120.
0.00E-10	3400.	120.
0.00E-10	3340.	120.
0.00E-10	3280.	120.
0.00E-10	3210.	120.
0.00E-10	3140.	120.
0.00E-10	3070.	120.
0.00E-10	3000.	120.
0.00E-10	2930.	120.

0.10E-10	2860.	120.
0.18E-10	2790.	120.
0.30E-10	2720.	120.
0.48E-10	2650.	120.
0.68E-10	2580.	120.
0.89E-10	2510.	120.
1.23E-10	2440.	120.
1.60E-10	2370.	120.
2.00E-10	2300.	120.
2.48E-10	2230.	120.
3.00E-10	2160.	120.
3.40E-10	2090.	120.
3.70E-10	2020.	120.
3.80E-10	1950.	120.
3.90E-10	1880.	120.
4.10E-10	1810.	120.
4.50E-10	1740.	120.
4.90E-10	1705.	60.
5.50E-10	1670.	60.
5.90E-10	1640.	60.
6.20E-10	1600.	60.
6.40E-10	1560.	60.
7.20E-10	1520.	60.

THIRD REFREEZE OF RTF4 RUN # F211 5/1/83
SAMPLE THICKNESS=0.37inches DOPED ICE VCH.=1500
FROZEN UNDER CARBON DIOXIDE ATMOSPHERE

83	20.	0.019
0.58E-10	5200.	0.0
0.79E-10	5175.	60.
1.24E-10	5150.	60.
1.80E-10	5125.	60.
2.70E-10	5100.	60.
3.40E-10	5075.	60.
4.10E-10	5050.	60.
4.80E-10	5025.	60.
5.38E-10	5000.	60.
5.80E-10	4975.	60.
5.95E-10	4950.	60.
5.88E-10	4925.	60.
5.30E-10	4900.	60.
4.65E-10	4875.	60.
4.00E-10	4850.	60.
3.45E-10	4825.	60.
2.80E-10	4800.	60.
2.00E-10	4775.	60.
1.47E-10	4750.	60.
1.18E-10	4725.	60.
0.90E-10	4700.	60.
0.57E-10	4675.	60.
0.34E-10	4650.	60.
0.18E-10	4625.	60.
0.00E-10	4600.	60.
0.00E-10	4575.	60.
0.00E-10	4550.	60.
0.00E-10	4525.	60.
0.00E-10	4500.	60.
0.00E-10	4475.	60.
0.00E-10	4450.	60.
0.00E-10	4425.	60.
0.00E-10	4400.	60.
0.00E-10	4375.	60.
0.00E-10	4350.	60.
0.00E-10	4325.	60.
0.00E-10	4300.	60.
0.00E-10	4275.	60.
0.00E-10	4250.	60.
0.00E-10	4225.	60.
0.00E-10	4165.	120.
0.00E-10	4105.	120.
0.00E-10	4045.	120.
0.00E-10	3985.	120.
0.00E-10	3920.	120.
0.00E-10	3860.	120.
0.05E-10	3800.	120.
0.09E-10	3740.	120.
0.13E-10	3680.	120.
0.24E-10	3620.	120.
0.38E-10	3560.	120.
0.50E-10	3595.	120.
0.62E-10	3430.	120.
0.70E-10	3365.	120.
0.72E-10	3300.	120.
0.79E-10	3235.	120.
0.87E-10	3160.	120.
1.00E-10	3095.	120.
1.25E-10	3030.	120.
1.70E-10	2965.	120.

2.30E-10	2900.	120.
3.10E-10	2835.	120.
3.80E-10	2770.	120.
4.60E-10	2705.	120.
5.72E-10	2640.	120.
6.80E-10	2575.	120.
8.30E-10	2505.	120.
9.50E-10	2440.	120.
9.76E-10	2370.	120.
9.33E-10	2300.	120.
9.90E-10	2230.	120.
9.95E-10	2160.	120.
10.0E-10	2080.	120.
12.0E-10	2000.	120.
15.0E-10	1920.	120.
17.8E-10	1840.	120.
18.2E-10	1760.	120.
17.8E-10	1720.	60.
17.0E-10	1680.	60.
16.2E-10	1640.	60.
15.0E-10	1600.	60.
13.8E-10	1560.	60.
12.2E-10	1520.	60.

SAMPLE # RTF5 RUN # F212 5/23/83
SAMPLE THICKNESS=.37inches (34) PURE ICE VCH.=1500
FROZEN UNDER AN 11 PSI VACUUM

83	20.	0.019
0.90E-10	5175.	0.0
1.10E-10	5150.	60.
1.60E-10	5125.	60.
2.20E-10	5100.	60.
3.00E-10	5075.	60.
3.70E-10	5050.	60.
4.10E-10	5025.	60.
4.60E-10	5000.	60.
4.97E-10	4975.	60.
5.18E-10	4950.	60.
5.17E-10	4925.	60.
4.93E-10	4900.	60.
4.58E-10	4875.	60.
3.90E-10	4850.	60.
3.20E-10	4825.	60.
2.70E-10	4800.	60.
2.28E-10	4775.	60.
2.05E-10	4750.	60.
1.92E-10	4725.	60.
1.91E-10	4700.	60.
1.93E-10	4675.	60.
1.99E-10	4650.	60.
2.08E-10	4625.	60.
2.21E-10	4600.	60.
2.40E-10	4575.	60.
2.65E-10	4550.	60.
2.88E-10	4525.	60.
2.99E-10	4500.	60.
2.91E-10	4475.	60.
2.70E-10	4450.	60.
2.37E-10	4425.	60.
1.90E-10	4400.	60.
1.40E-10	4375.	60.
1.10E-10	4350.	60.
0.90E-10	4325.	60.
0.77E-10	4300.	60.
0.70E-10	4270.	60.
0.64E-10	4240.	60.
0.61E-10	4210.	60.
0.60E-10	4180.	60.
0.58E-10	4150.	60.
0.56E-10	4120.	60.
0.52E-10	4090.	60.
0.51E-10	4060.	60.
0.50E-10	4030.	60.
0.51E-10	4000.	60.
0.57E-10	3940.	120.
0.60E-10	3880.	120.
0.61E-10	3820.	120.
0.67E-10	3760.	120.
0.70E-10	3700.	120.
0.73E-10	3640.	120.
0.87E-10	3580.	120.
1.00E-10	3520.	120.
1.15E-10	3460.	120.
1.24E-10	3400.	120.
1.30E-10	3330.	120.
1.31E-10	3260.	120.
1.33E-10	3190.	120.
1.40E-10	3130.	120.

1.60E-10	3070.	120.
1.80E-10	3000.	120.
2.06E-10	2930.	120.
2.30E-10	2860.	120.
2.62E-10	2790.	120.
2.79E-10	2720.	120.
2.77E-10	2650.	120.
2.60E-10	2580.	120.
2.48E-10	2510.	120.
2.41E-10	2440.	120.
2.60E-10	2370.	120.
2.89E-10	2300.	120.
3.28E-10	2230.	120.
3.57E-10	2160.	120.
3.90E-10	2090.	120.
4.55E-10	2020.	120.
5.05E-10	1950.	120.
5.78E-10	1880.	120.
6.02E-10	1810.	120.
6.50E-10	1740.	120.
7.20E-10	1660.	120.
8.40E-10	1580.	120.
8.13E-10	1500.	120.

SECOND REFREEZE OF RTF5 RUN # F213 5/26/83
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
FROZEN UNDER AN 11 PSI VACUUM

83	20.	0.019
0.60E-10	5200.	0.0
0.81E-10	5180.	60.
1.10E-10	5160.	60.
1.35E-10	5140.	60.
1.75E-10	5120.	60.
2.40E-10	5100.	60.
3.20E-10	5075.	60.
4.20E-10	5050.	60.
5.07E-10	5025.	60.
5.60E-10	5000.	60.
6.60E-10	4975.	60.
7.60E-10	4950.	60.
8.00E-10	4925.	60.
7.90E-10	4900.	60.
7.13E-10	4875.	60.
5.70E-10	4850.	60.
4.30E-10	4825.	60.
3.30E-10	4800.	60.
2.40E-10	4775.	60.
1.68E-10	4750.	60.
1.43E-10	4725.	60.
1.30E-10	4700.	60.
1.18E-10	4675.	60.
1.11E-10	4650.	60.
1.10E-10	4625.	60.
1.17E-10	4600.	60.
1.18E-10	4575.	60.
1.11E-10	4550.	60.
1.03E-10	4525.	60.
0.91E-10	4500.	60.
0.80E-10	4475.	60.
0.60E-10	4450.	60.
0.50E-10	4425.	60.
0.40E-10	4400.	60.
0.30E-10	4375.	60.
0.20E-10	4350.	60.
0.10E-10	4325.	60.
0.05E-10	4300.	60.
0.00E-10	4275.	60.
0.00E-10	4250.	60.
0.00E-10	4225.	60.
0.00E-10	4200.	60.
0.00E-10	4175.	60.
0.00E-10	4150.	60.
0.00E-10	4125.	60.
0.00E-10	4060.	120.
0.00E-10	4000.	120.
0.01E-10	3940.	120.
0.10E-10	3870.	120.
0.20E-10	3800.	120.
0.30E-10	3730.	120.
0.43E-10	3660.	120.
0.55E-10	3590.	120.
0.69E-10	3530.	120.
0.78E-10	3470.	120.
0.85E-10	3410.	120.
0.87E-10	3350.	120.
0.88E-10	3290.	120.
0.88E-10	3220.	120.
0.89E-10	3150.	120.

0.97E-10	3080.	120.
1.03E-10	3020.	120.
1.20E-10	2950.	120.
1.35E-10	2880.	120.
1.60E-10	2810.	120.
1.90E-10	2740.	120.
2.25E-10	2670.	120.
2.60E-10	2600.	120.
2.85E-10	2530.	120.
3.10E-10	2460.	120.
3.28E-10	2390.	120.
3.30E-10	2320.	120.
3.35E-10	2250.	120.
3.55E-10	2180.	120.
3.60E-10	2120.	120.
3.74E-10	2060.	120.
4.08E-10	2000.	120.
4.50E-10	1930.	120.
4.95E-10	1860.	120.
5.30E-10	1790.	120.
5.40E-10	1720.	120.
4.80E-10	1650.	120.
3.40E-10	1580.	120.

THIRD REFREEZE OF RTF5 RUN # F214 6/16/83
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
SAMPLE FROZEN UNDER AN 11 PSI VACUUM

83	20.	0.019
0.75E-10	5200.	0.0
1.00E-10	5180.	60.
1.27E-10	5160.	60.
1.59E-10	5140.	60.
2.23E-10	5120.	60.
3.10E-10	5100.	60.
4.30E-10	5075.	60.
5.30E-10	5050.	60.
6.35E-10	5025.	60.
7.40E-10	5000.	60.
7.98E-10	4975.	60.
8.20E-10	4950.	60.
8.07E-10	4925.	60.
7.60E-10	4900.	60.
6.00E-10	4875.	60.
4.30E-10	4850.	60.
3.00E-10	4825.	60.
2.20E-10	4800.	60.
1.40E-10	4775.	60.
0.85E-10	4750.	60.
0.70E-10	4725.	60.
0.69E-10	4700.	60.
0.69E-10	4675.	60.
0.69E-10	4650.	60.
0.69E-10	4625.	60.
0.70E-10	4600.	60.
0.70E-10	4575.	60.
0.71E-10	4550.	60.
0.70E-10	4525.	60.
0.69E-10	4500.	60.
0.65E-10	4475.	60.
0.59E-10	4450.	60.
0.52E-10	4425.	60.
0.48E-10	4400.	60.
0.40E-10	4375.	60.
0.33E-10	4350.	60.
0.26E-10	4325.	60.
0.20E-10	4300.	60.
0.15E-10	4275.	60.
0.12E-10	4250.	60.
0.09E-10	4225.	60.
0.05E-10	4200.	60.
0.03E-10	4175.	60.
0.00E-10	4120.	120.
0.00E-10	4070.	120.
0.01E-10	4010.	120.
0.05E-10	3950.	120.
0.10E-10	3880.	120.
0.16E-10	3810.	120.
0.21E-10	3750.	120.
0.29E-10	3690.	120.
0.35E-10	3630.	120.
0.45E-10	3570.	120.
0.52E-10	3500.	120.
0.60E-10	3430.	120.
0.69E-10	3360.	120.
0.72E-10	3290.	120.
0.80E-10	3230.	120.
0.87E-10	3160.	120.
0.90E-10	3090.	120.

0.95E-10	3030.	120.
1.00E-10	2960.	120.
1.18E-10	2890.	120.
1.38E-10	2820.	120.
1.65E-10	2750.	120.
2.00E-10	2680.	120.
2.38E-10	2610.	120.
2.79E-10	2550.	120.
3.28E-10	2490.	120.
3.68E-10	2420.	120.
3.89E-10	2350.	120.
3.50E-10	2290.	120.
3.52E-10	2230.	120.
4.00E-10	2170.	120.
4.22E-10	2110.	120.
4.70E-10	2040.	120.
5.17E-10	1970.	120.
5.63E-10	1900.	120.
5.87E-10	1830.	120.
5.92E-10	1750.	120.
5.85E-10	1670.	120.
5.03E-10	1590.	120.
4.60E-10	1510.	120.

FOURTH REFREEZE OF RTF5 RUN # F215 6/19/83
SAMPLE THICKNESS=0.37inches DOPED ICE VCH.=1500
FROZEN UNDER A CARBON DIOXIDE ATMOSPHERE

83	20.	0.019
0.40E-10	5150.	0.0
0.58E-10	5125.	60.
0.90E-10	5100.	60.
1.40E-10	5075.	60.
2.00E-10	5050.	60.
2.65E-10	5025.	60.
3.20E-10	5000.	60.
4.10E-10	4975.	60.
5.00E-10	4950.	60.
5.85E-10	4925.	60.
6.35E-10	4900.	60.
6.60E-10	4875.	60.
6.38E-10	4850.	60.
5.70E-10	4825.	60.
4.95E-10	4800.	60.
4.00E-10	4775.	60.
3.00E-10	4750.	60.
2.50E-10	4725.	60.
2.00E-10	4700.	60.
1.72E-10	4675.	60.
1.45E-10	4650.	60.
1.23E-10	4625.	60.
1.18E-10	4600.	60.
1.12E-10	4575.	60.
1.10E-10	4550.	60.
1.09E-10	4525.	60.
1.07E-10	4500.	60.
1.00E-10	4475.	60.
0.93E-10	4450.	60.
0.87E-10	4425.	60.
0.80E-10	4400.	60.
0.73E-10	4375.	60.
0.65E-10	4350.	60.
0.59E-10	4325.	60.
0.52E-10	4300.	60.
0.50E-10	4275.	60.
0.48E-10	4250.	60.
0.42E-10	4225.	60.
0.40E-10	4200.	60.
0.39E-10	4175.	60.
0.39E-10	4150.	60.
0.38E-10	4125.	60.
0.37E-10	4100.	60.
0.36E-10	4075.	60.
0.35E-10	4050.	60.
0.34E-10	3990.	120.
0.39E-10	3920.	120.
0.52E-10	3860.	120.
0.68E-10	3800.	120.
1.00E-10	3740.	120.
1.53E-10	3680.	120.
2.20E-10	3620.	120.
3.20E-10	3560.	120.
4.50E-10	3490.	120.
5.64E-10	3420.	120.
6.39E-10	3350.	120.
6.90E-10	3280.	120.
7.08E-10	3210.	120.
6.80E-10	3140.	120.
6.20E-10	3070.	120.

5.50E-10	3000.	120.
5.08E-10	2930.	120.
4.97E-10	2860.	120.
5.20E-10	2790.	120.
5.55E-10	2720.	120.
6.08E-10	2650.	120.
6.68E-10	2580.	120.
7.02E-10	2520.	120.
7.18E-10	2460.	120.
6.98E-10	2390.	120.
5.60E-10	2320.	120.
4.20E-10	2250.	120.
3.15E-10	2180.	120.
2.67E-10	2110.	120.
2.41E-10	2060.	120.
2.39E-10	1990.	120.
2.39E-10	1920.	120.
2.39E-10	1850.	120.
2.45E-10	1780.	120.
2.68E-10	1710.	120.
2.80E-10	1630.	120.
2.90E-10	1550.	120.
3.22E-10	1470.	120.

SAMPLE # RTF6 RUN # F216 6/22/83
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
FROZEN UNDER AN 11 PSI VACUUM
83 20. 0.019

0.27E-10	5100.	0.0
0.37E-10	5080.	60.
0.58E-10	5060.	60.
0.80E-10	5040.	60.
1.17E-10	5020.	60.
1.68E-10	5000.	60.
2.35E-10	4975.	60.
3.35E-10	4950.	60.
4.40E-10	4925.	60.
5.90E-10	4900.	60.
7.40E-10	4875.	60.
8.90E-10	4850.	60.
9.80E-10	4825.	60.
9.10E-10	4800.	60.
8.00E-10	4775.	60.
6.10E-10	4750.	60.
4.70E-10	4725.	60.
3.50E-10	4700.	60.
3.02E-10	4675.	60.
2.75E-10	4650.	60.
2.47E-10	4625.	60.
2.21E-10	4600.	60.
1.98E-10	4575.	60.
1.70E-10	4550.	60.
1.40E-10	4525.	60.
1.17E-10	4500.	60.
1.00E-10	4475.	60.
0.83E-10	4450.	60.
0.73E-10	4425.	60.
0.62E-10	4400.	60.
0.52E-10	4370.	60.
0.48E-10	4340.	60.
0.40E-10	4310.	60.
0.39E-10	4280.	60.
0.35E-10	4250.	60.
0.31E-10	4220.	60.
0.30E-10	4190.	60.
0.26E-10	4160.	60.
0.25E-10	4130.	60.
0.25E-10	4100.	60.
0.25E-10	4070.	60.
0.28E-10	4010.	120.
0.39E-10	3950.	120.
0.51E-10	3890.	120.
0.67E-10	3830.	120.
0.78E-10	3770.	120.
0.88E-10	3710.	120.
1.00E-10	3650.	120.
1.20E-10	3590.	120.
1.52E-10	3530.	120.
1.90E-10	3470.	120.
2.05E-10	3410.	120.
2.10E-10	3350.	120.
2.02E-10	3290.	120.
1.97E-10	3220.	120.
1.92E-10	3150.	120.
1.91E-10	3080.	120.
1.92E-10	3010.	120.
2.00E-10	2940.	120.
2.11E-10	2870.	120.

2.21E-10	2800.	120.
2.33E-10	2730.	120.
2.52E-10	2660.	120.
2.73E-10	2590.	120.
3.05E-10	2520.	120.
3.53E-10	2450.	120.
4.19E-10	2380.	120.
4.88E-10	2310.	120.
5.38E-10	2240.	120.
5.67E-10	2170.	120.
5.85E-10	2090.	120.
5.98E-10	2010.	120.
6.14E-10	1930.	120.
6.30E-10	1850.	120.
6.42E-10	1770.	120.
6.55E-10	1730.	60.
6.70E-10	1690.	60.
6.75E-10	1650.	60.
6.78E-10	1610.	60.
6.73E-10	1570.	60.
6.70E-10	1530.	60.
6.65E-10	1490.	60.
6.55E-10	1450.	60.

FIRST REFREEZE OF RTF6 RUN # F217 6/26/83
SAMPLE THICKNESS=0.37inches PURE ICE VCH.=1500
FROZEN UNDER AN 11 PSI VACUUM

83	20.	0.019
0.37E-10	5150.	0.0
0.68E-10	5125.	60.
1.30E-10	5100.	60.
2.05E-10	5075.	60.
3.30E-10	5050.	60.
4.65E-10	5025.	60.
6.10E-10	5000.	60.
7.50E-10	4975.	60.
9.10E-10	4950.	60.
10.9E-10	4925.	60.
11.9E-10	4900.	60.
10.9E-10	4875.	60.
8.80E-10	4850.	60.
7.40E-10	4825.	60.
4.70E-10	4800.	60.
2.60E-10	4775.	60.
1.47E-10	4750.	60.
1.08E-10	4720.	60.
1.00E-10	4690.	60.
0.99E-10	4660.	60.
1.00E-10	4630.	60.
1.00E-10	4600.	60.
0.99E-10	4570.	60.
0.96E-10	4540.	60.
0.88E-10	4510.	60.
0.80E-10	4480.	60.
0.69E-10	4450.	60.
0.59E-10	4425.	60.
0.50E-10	4400.	60.
0.41E-10	4375.	60.
0.32E-10	4350.	60.
0.29E-10	4325.	60.
0.23E-10	4300.	60.
0.20E-10	4275.	60.
0.18E-10	4250.	60.
0.15E-10	4225.	60.
0.11E-10	4200.	60.
0.10E-10	4170.	60.
0.10E-10	4140.	60.
0.10E-10	4110.	60.
0.10E-10	4080.	60.
0.10E-10	4050.	60.
0.10E-10	4020.	60.
0.10E-10	3990.	60.
0.11E-10	3960.	60.
0.13E-10	3900.	120.
0.20E-10	3840.	120.
0.22E-10	3780.	120.
0.25E-10	3720.	120.
0.30E-10	3660.	120.
0.42E-10	3600.	120.
0.62E-10	3540.	120.
0.84E-10	3480.	120.
1.08E-10	3410.	120.
1.39E-10	3340.	120.
1.45E-10	3270.	120.
1.59E-10	3200.	120.
1.69E-10	3130.	120.
1.89E-10	3060.	120.
2.10E-10	3000.	120.

2.38E-10	2940.	120.
2.70E-10	2870.	120.
3.08E-10	2800.	120.
3.36E-10	2740.	120.
3.69E-10	2680.	120.
4.19E-10	2610.	120.
4.95E-10	2540.	120.
6.00E-10	2470.	120.
7.20E-10	2400.	120.
8.60E-10	2340.	120.
9.60E-10	2270.	120.
10.6E-10	2200.	120.
11.0E-10	2130.	120.
10.7E-10	2060.	120.
9.70E-10	1990.	120.
7.60E-10	1920.	120.
6.40E-10	1840.	120.
5.10E-10	1760.	120.
4.50E-10	1680.	120.
4.35E-10	1600.	120.
4.25E-10	1560.	60.
3.90E-10	1520.	60.
3.50E-10	1480.	60.

THIRD REFREEZE OF RTF6 RUN # F218 6/30/83
SAMPLE THICKNESS=0.37 inches (83) PURE ICE VCH.=1500
SAMPLE FROZEN UNDER AN 11 PSI VACUUM

26	20.	0.019
0.38E-10	5200.	0.0
0.54E-10	5180.	60.
0.75E-10	5160.	60.
1.20E-10	5140.	60.
1.70E-10	5120.	60.
2.65E-10	5100.	60.
3.60E-10	5075.	60.
4.70E-10	5050.	60.
5.80E-10	5025.	60.
7.70E-10	5000.	60.
10.0E-10	4975.	60.
11.3E-10	4950.	60.
11.9E-10	4925.	60.
11.4E-10	4900.	60.
10.0E-10	4875.	60.
7.60E-10	4850.	60.
4.60E-10	4825.	60.
2.70E-10	4800.	60.
1.50E-10	4775.	60.
0.90E-10	4750.	60.
0.72E-10	4725.	60.
0.63E-10	4700.	60.
0.58E-10	4675.	60.
0.52E-10	4650.	60.
0.50E-10	4625.	60.
0.50E-10	4600.	60.
0.50E-10	4575.	60.
0.50E-10	4550.	60.
0.50E-10	4525.	60.
0.50E-10	4500.	60.
0.49E-10	4475.	60.
0.48E-10	4450.	60.
0.48E-10	4425.	60.
0.47E-10	4400.	60.
0.43E-10	4375.	60.
0.41E-10	4350.	60.
0.40E-10	4325.	60.
0.39E-10	4300.	60.
0.39E-10	4275.	60.
0.40E-10	4250.	60.
0.40E-10	4225.	60.
0.40E-10	4175.	120.
0.40E-10	4110.	120.
0.40E-10	4050.	120.
0.40E-10	3990.	120.
0.40E-10	3930.	120.
0.40E-10	3870.	120.
0.44E-10	3810.	120.
0.50E-10	3745.	120.
0.60E-10	3680.	120.
0.72E-10	3615.	120.
0.80E-10	3550.	120.
0.81E-10	3485.	120.
0.80E-10	3420.	120.
0.79E-10	3355.	120.
0.78E-10	3290.	120.
0.79E-10	3225.	120.
0.82E-10	3160.	120.
0.89E-10	3095.	120.
0.99E-10	3030.	120.

1.10E-10	2965.	120.
1.30E-10	2900.	120.
1.40E-10	2835.	120.
1.62E-10	2770.	120.
1.89E-10	2705.	120.
2.20E-10	2640.	120.
2.58E-10	2575.	120.
2.88E-10	2510.	120.
3.18E-10	2440.	120.
3.39E-10	2370.	120.
3.51E-10	2300.	120.
3.57E-10	2230.	120.
3.58E-10	2160.	120.
3.52E-10	2090.	120.
3.50E-10	2020.	120.
3.46E-10	1940.	120.
3.44E-10	1860.	120.
3.49E-10	1780.	120.
3.55E-10	1700.	120.
3.80E-10	1620.	120.
5.00E-10	1540.	120.
5.68E-10	1460.	120.
5.62E-10	1420.	60.

FOURTH REFREEZE OF RTF6 RUN # F219 7/3/83
SAMPLE THICKNESS=0.37inches (83) DOPED ICE VCH.=1500
SAMPLE FROZEN UNDER CARBON DIOXIDE

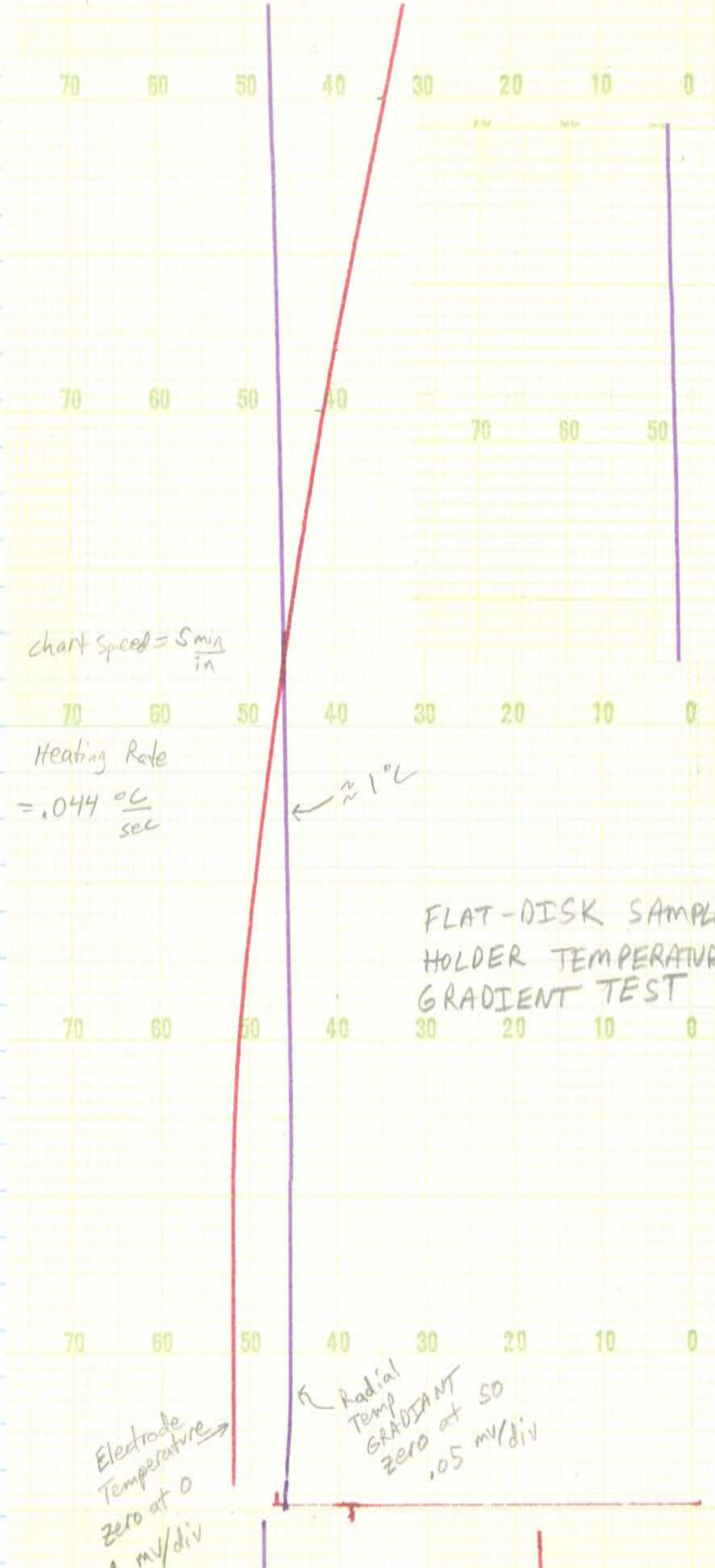
25	20.	0.019
0.70E-10	5100.	0.0
1.00E-10	5080.	60.
1.55E-10	5060.	60.
2.08E-10	5040.	60.
3.00E-10	5020.	60.
4.20E-10	5000.	60.
5.50E-10	4975.	60.
7.10E-10	4950.	60.
8.60E-10	4925.	60.
8.98E-10	4900.	60.
8.68E-10	4875.	60.
7.50E-10	4850.	60.
5.60E-10	4825.	60.
3.50E-10	4800.	60.
2.10E-10	4775.	60.
1.50E-10	4750.	60.
1.00E-10	4725.	60.
0.82E-10	4700.	60.
0.65E-10	4675.	60.
0.51E-10	4650.	60.
0.42E-10	4625.	60.
0.37E-10	4600.	60.
0.30E-10	4575.	60.
0.27E-10	4550.	60.
0.21E-10	4525.	60.
0.18E-10	4500.	60.
0.11E-10	4475.	60.
0.10E-10	4450.	60.
0.08E-10	4420.	60.
0.03E-10	4390.	60.
0.01E-10	4360.	60.
0.00E-10	4330.	60.
0.00E-10	4300.	60.
0.00E-10	4270.	60.
0.00E-10	4240.	60.
0.00E-10	4210.	60.
0.00E-10	4180.	60.
0.00E-10	4150.	60.
0.00E-10	4120.	60.
0.00E-10	4090.	60.
0.00E-10	4030.	120.
0.00E-10	3970.	120.
0.00E-10	3910.	120.
0.00E-10	3850.	120.
0.01E-10	3790.	120.
0.06E-10	3730.	120.
0.10E-10	3670.	120.
0.20E-10	3610.	120.
0.31E-10	3550.	120.
0.45E-10	3490.	120.
0.68E-10	3430.	120.
1.00E-10	3370.	120.
1.45E-10	3310.	120.
2.00E-10	3240.	120.
2.58E-10	3170.	120.
3.07E-10	3100.	120.
3.38E-10	3030.	120.
3.68E-10	2960.	120.
3.88E-10	2890.	120.
3.89E-10	2820.	120.

3.77E-10	2750.	120.
3.52E-10	2680.	120.
3.40E-10	2610.	120.
3.70E-10	2540.	120.
4.30E-10	2470.	120.
5.05E-10	2400.	120.
6.05E-10	2330.	120.
7.05E-10	2260.	120.
8.25E-10	2190.	120.
8.40E-10	2120.	120.
8.00E-10	2050.	120.
7.20E-10	1980.	120.
6.10E-10	1910.	120.
5.15E-10	1840.	120.
4.48E-10	1760.	120.
4.23E-10	1720.	60.
4.08E-10	1680.	60.
3.93E-10	1640.	60.
3.78E-10	1600.	60.
3.68E-10	1560.	60.
3.50E-10	1520.	60.
3.37E-10	1480.	60.
3.22E-10	1440.	60.

APPENDIX IX-TEMPERATURE GRADIENT TESTS

THIS APPENDIX CONTAINS THE RESULTS OF TEMPERATURE GRADIENT TESTS RUN ON THE FLAT-DISK SAMPLE HOLDER AND THE CONCENTRIC-CYLINDER SAMPLE HOLDER. DIFFERENTIAL THERMOCOUPLE ARRANGEMENTS WERE USED TO RECORD THE TEMPERATURE GRADIENTS. FOR THE CONCENTRIC-CYLINDER SAMPLE HOLDER THE HORIZONTAL TEMPERATURE GRADIENT WAS MEASURED WITH A DIGITAL VOLT-OHM METER AND WRITTEN DOWN AT VARIOUS TEMPERATURES ON THE STRIP CHART.

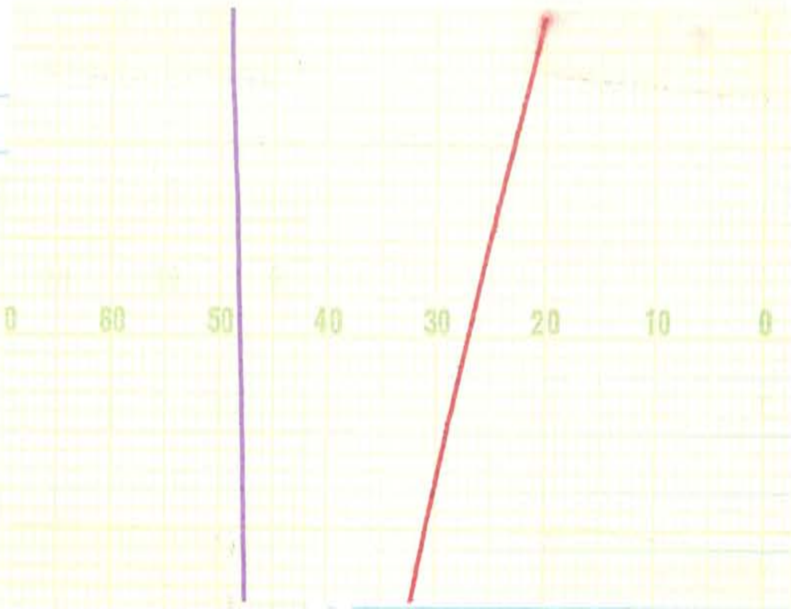
6/1/82

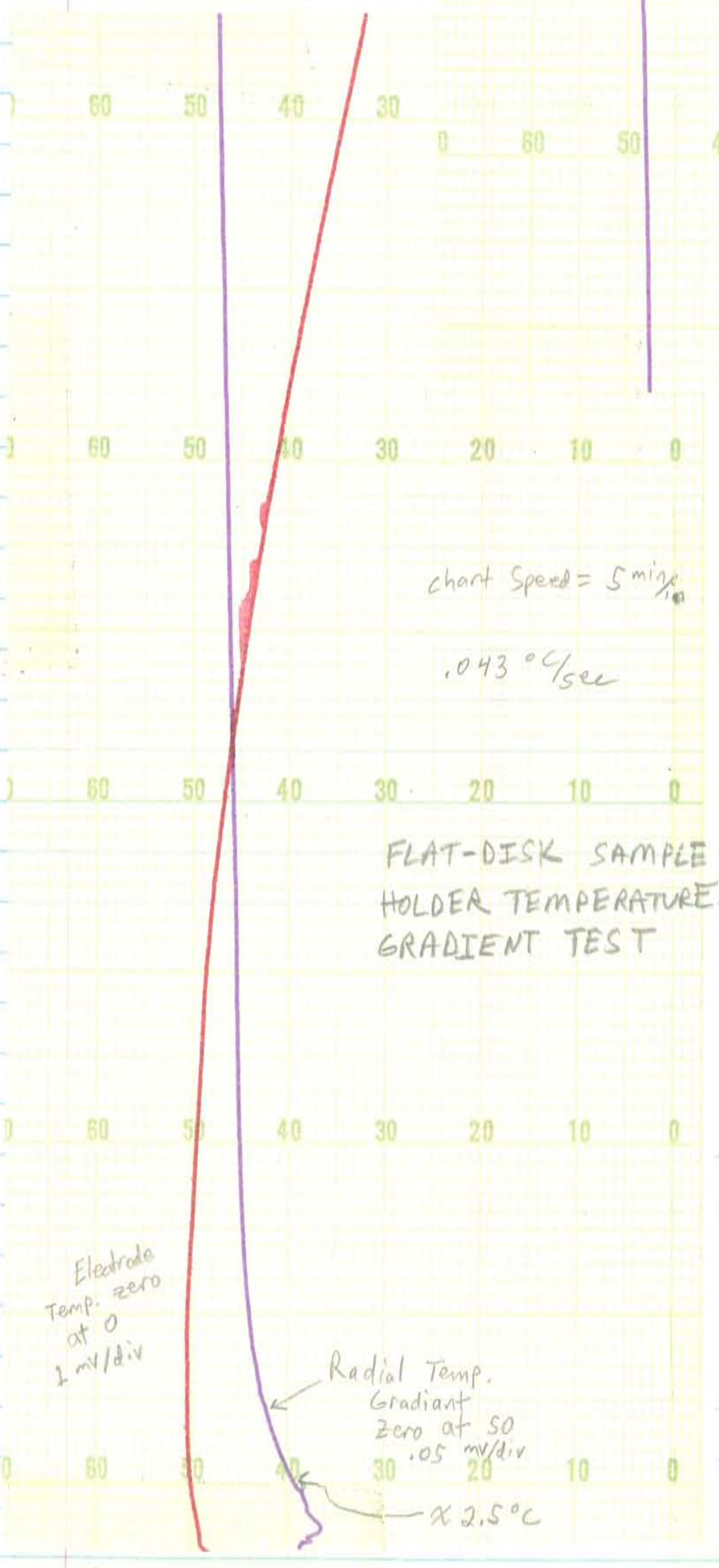


Ice sample is ≈ ½" thick. It was slowly cooled overnight before this test was run

Test done with the plain electrode and not the gaurd electrode

6/3/82

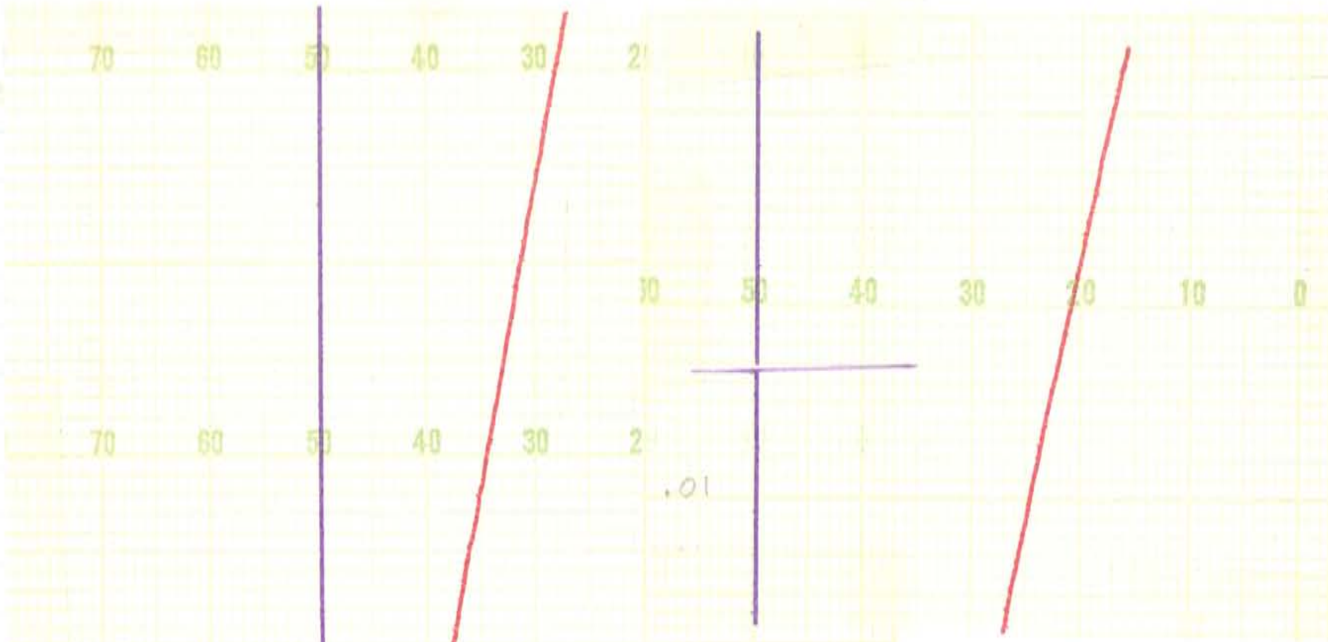


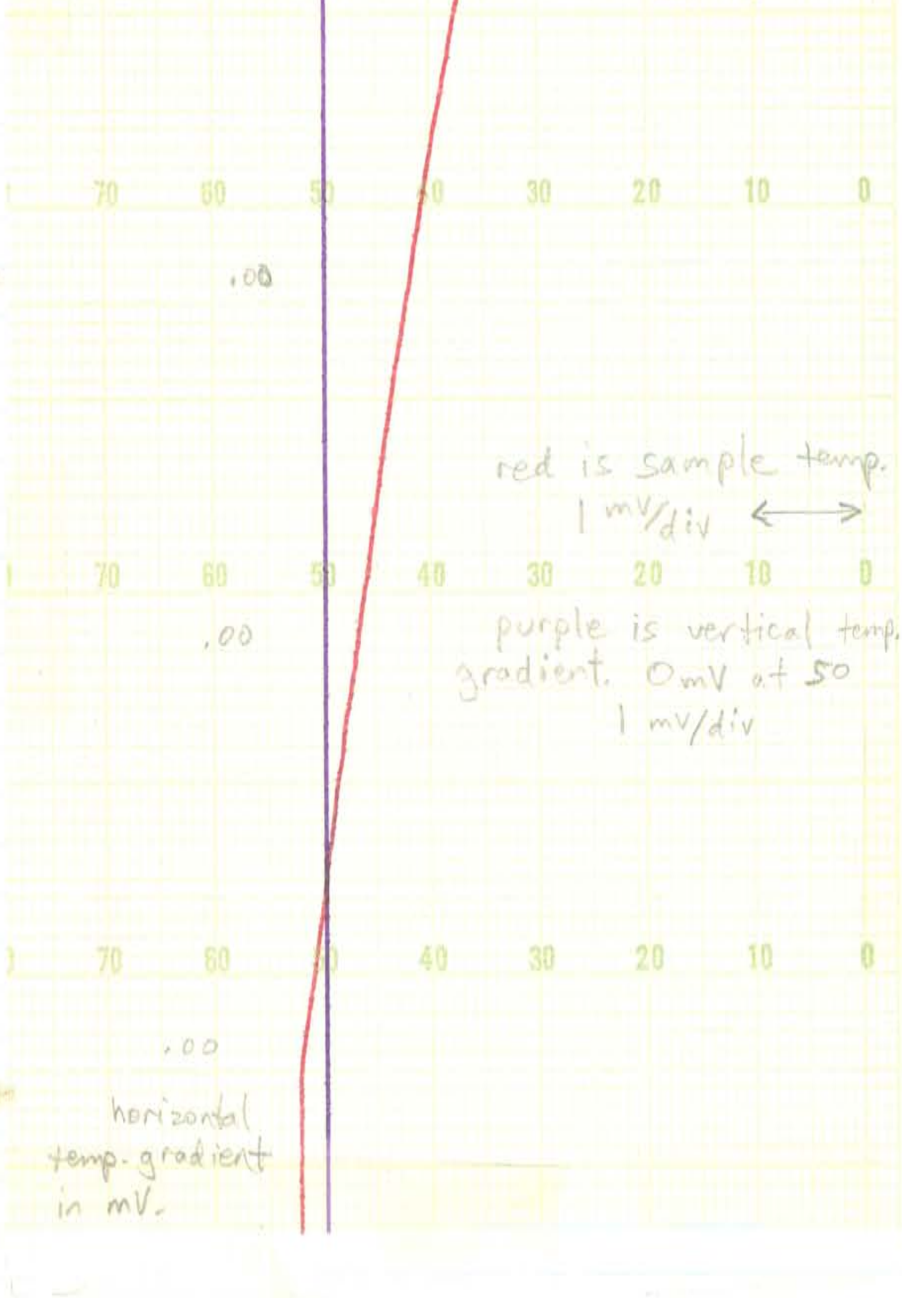


Ice sample is ≈ 1/2" thick. It was cooled rapidly and then allowed to sit for ≈ 2 minutes. Temp. was controlled at -100°C before cooling

Test done with the plain electrode and not the gaurd electrode

5/19/83





CONCENTRIC-CYLINDER SAMPLE HOLDER TEMPERATURE GRADIENT TEST. (Teflon Blocking Layers Were Used)

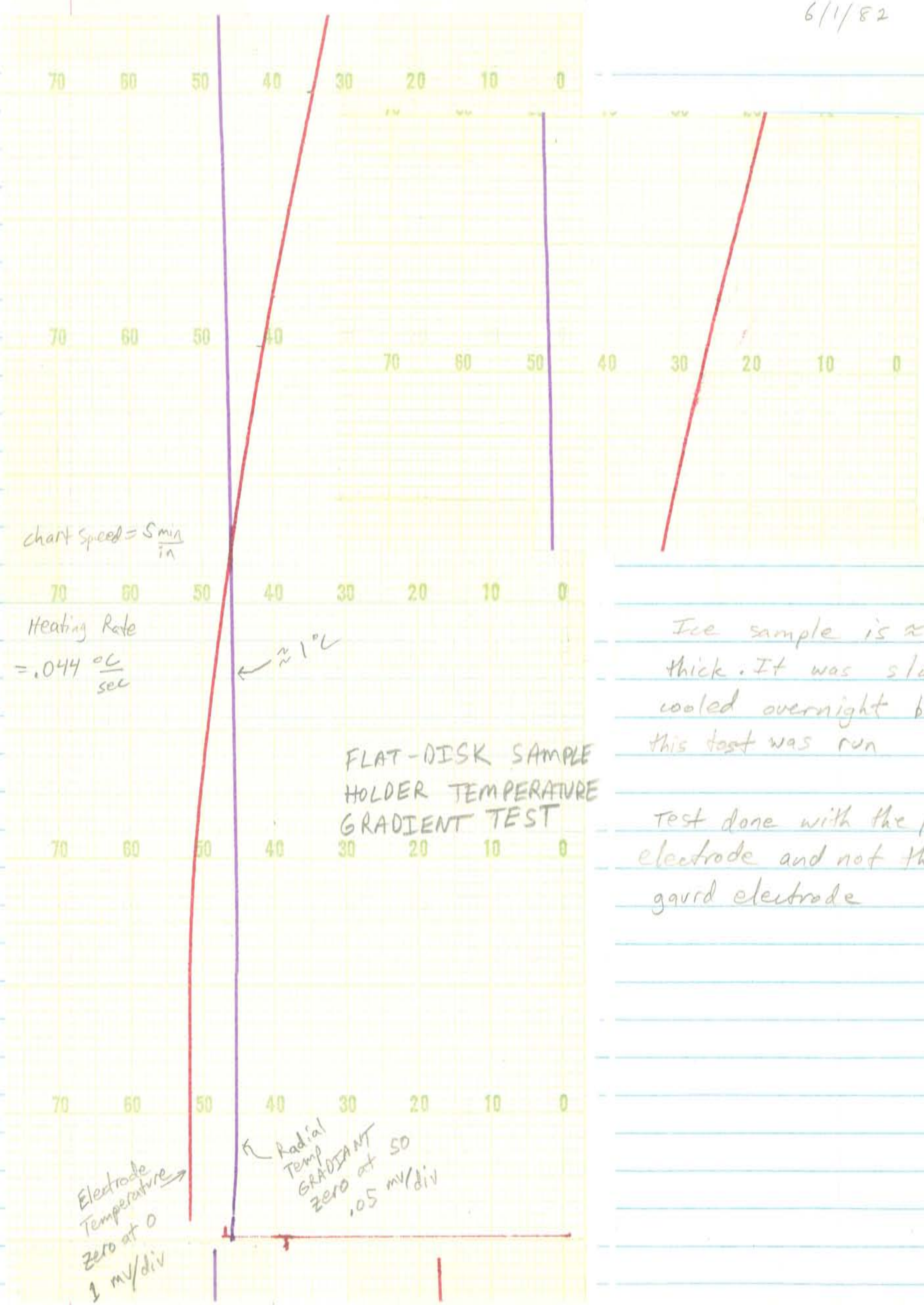
Sample was cooled by normal procedure = 24 hrs.

Heating Rate = 0.019 °K/sec

APPENDIX IX-TEMPERATURE GRADIENT TESTS

THIS APPENDIX CONTAINS THE RESULTS OF TEMPERATURE GRADIENT TESTS RUN ON THE FLAT-DISK SAMPLE HOLDER AND THE CONCENTRIC-CYLINDER SAMPLE HOLDER. DIFFERENTIAL THERMOCOUPLE ARRANGEMENTS WERE USED TO RECORD THE TEMPERATURE GRADIENTS. FOR THE CONCENTRIC-CYLINDER SAMPLE HOLDER THE HORIZONTAL TEMPERATURE GRADIENT WAS MEASURED WITH A DIGITAL VOLT-OHM METER AND WRITTEN DOWN AT VARIOUS TEMPERATURES ON THE STRIP CHART.

6/1/82

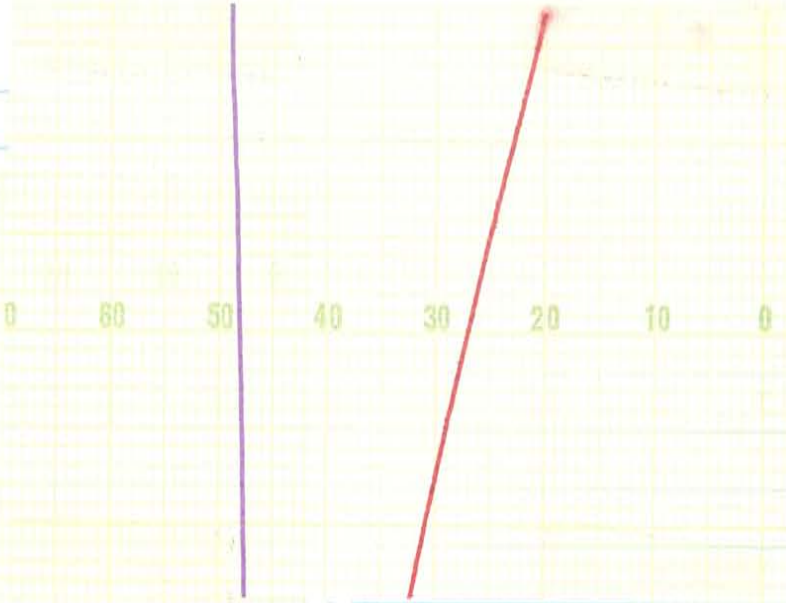


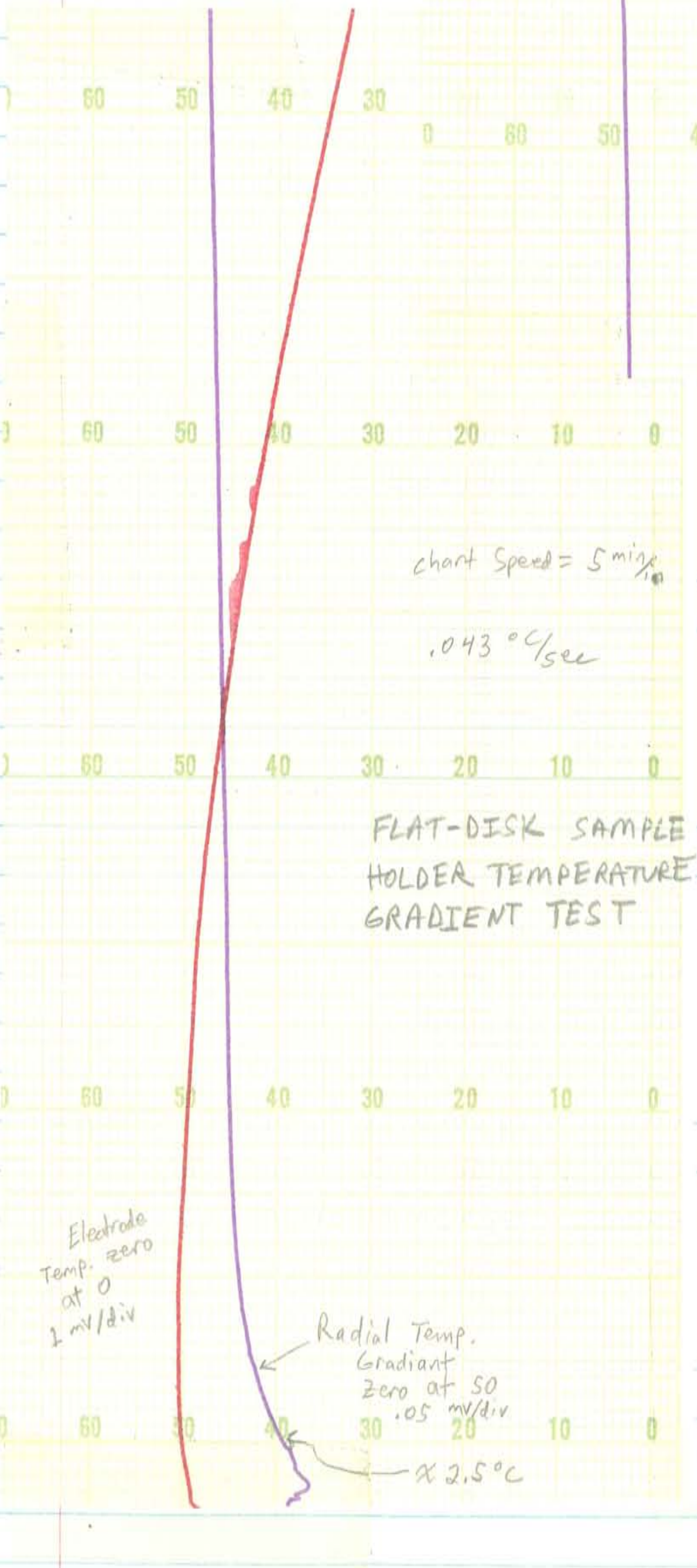
FLAT-DISK SAMPLE HOLDER TEMPERATURE GRADIENT TEST

Ice sample is ≈ ½" thick. It was slowly cooled overnight before this test was run

Test done with the plain electrode and not the gaurd electrode

6/3/82

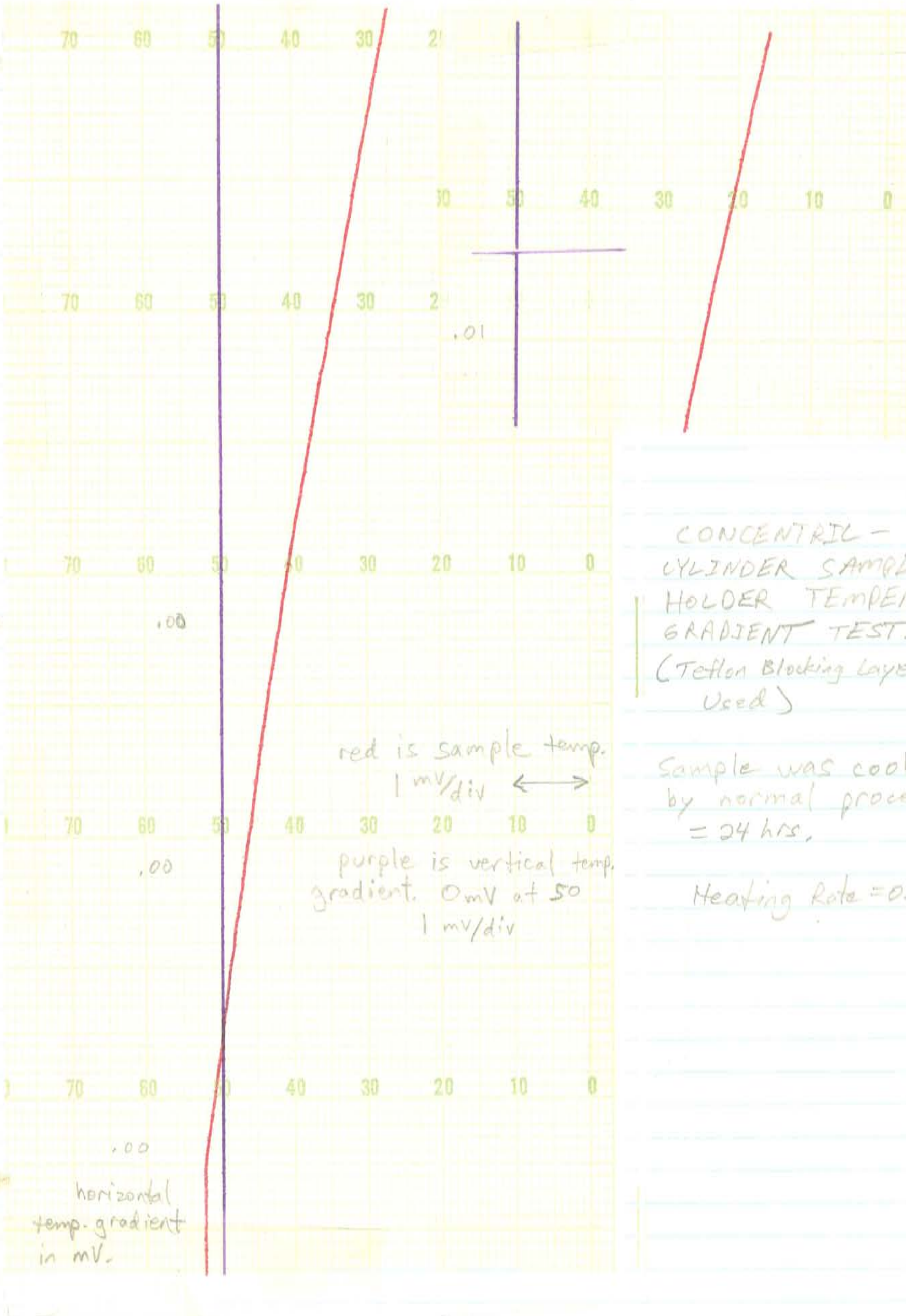




Ice sample is ≈ 1/2" thick. It was cooled rapidly and then allowed to sit for ≈ 2 minutes. Temp. was controlled at -100°C before cooling

Test done with the plain electrode and not the gaurd electrode

5/19/83



CONCENTRIC-CYLINDER SAMPLE HOLDER TEMPERATURE GRADIENT TEST.
(Teflon Blocking Layers were Used)

Sample was cooled by normal procedure ≈ 24 hrs.

Heating Rate = 0.019 °K/sec