C H A P T E R   I I I

EXPERIMENTAL DETAILS

CHAPTER III

EXPERIMENTAL DETAILS

3.1 Preparation of Sample :

The samples are prepared using quenching method. Elements Se, Te and Sb are taken for preparation of samples. The atomic weights and melting points of above elements are as given below.

Element	Atomic weight	Melting point °C
Selenium (Se)	78.96	217
Tellurium (Te)	127.6	449
Antimony (Sb)	121.75	904

Six compositions of Se-Te with Sb in varying percentage are prepared. The formula used to calculate the weight of each element, to prepare the samples in the required ratios as given below.

1) Se_{70}-Te_{30}

= atomic weight of Se x 70 + atomic weight of Te x 30

$$= \frac{78.96 \times 70}{930} + \frac{127.6 \times 30}{930}$$ (ten grams weight of the total sample)

= 5.9432 + 4.1161

= 10.059 gms.

2) Similarly for Se_{70}-Te_{30-x} Sb_x

(where x = 1,3,5,7,9% atomic weight)

= Atomic weight of Se x 70 + Atomic weight of Te_{30-x}

+ Atomic weight of Sb_x

Using above formula the individual weight of each element is given below.

Sample	Weight of 'Se' in gm.	Weight of 'Te' in gm.	Weight of 'Sb' in gm.
$Se_{70}-Te_{30}$	5.943	4.116	-
$Se_{70}-Te_{29}Sb_3$	5.943	3.978	0.139
$Se_{70}-Te_{27}Sb_3$	5.943	3.704	0.392
$Se_{70}Te_{25}Sb_5$	5.943	3.430	0.654
$Se_{70}-Te_{23}Sb_7$	5.943	3.155	0.9163
$Se_{70}-Te_{21}Sb_9$	5.943	2.881	1.1782

Total

Se = 35.658

Te = 21.264

Sb = 3.2808

In order to prepare the samples, the contents were kept in Silica tubes (length 22cm, inner diameter 0.92cm and outer diameter 1cm). The tubes are cleaned three times with teepol chemical and then with distilled water. The cleaned tubes are dried at temperature 80°C in order to remove the moisture. The tubes with the contents are sealed under vacuum. The silica tubes were fitted to vaccum system. The tubes were connected with gas welding. The elements were taken in the form of granules in order to avoid the sucking with the help of rotatory and diffusion pumps, the tubes are evacuated to 10^{-6}torr for three hours. Then the silica tubes with the contents were again sealed with the help of gas welding.

The heating of silica tubes is done in an electric furnace. The tubes were held in a circular disc made up of fire bricks as shown in Fig. (3.1). Six tubes at a time, were kept in the furnace. A steel rod is fixed at the centre of the disc, which is used for rotating the samples in the electric furnace. The rod is rotated through 360° for homogeneous mixing of samples. samples are heated for 30 hours as given below.

Hours	Temperature °C
0 to 2	1 to 200
2 to 6	200 to 400
6 to 10	400 to 600
10 to 12	600 to 850
12 to 30	850 to -

After heating, the tubes for the required period, are taken out of furnace and suddenly quenched in ice

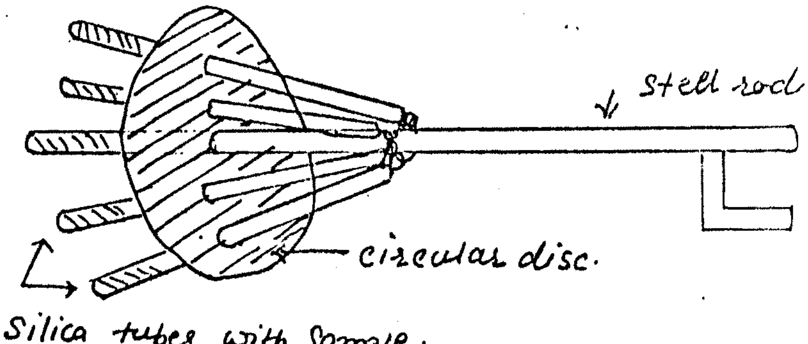

FIG.3.1

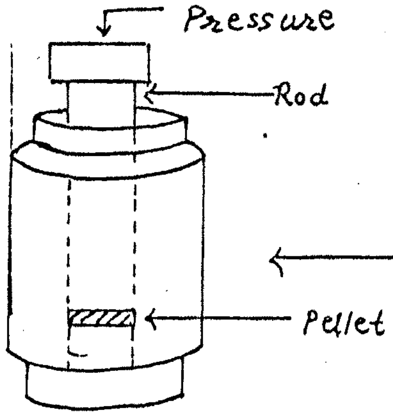

FIG.3.2 Die

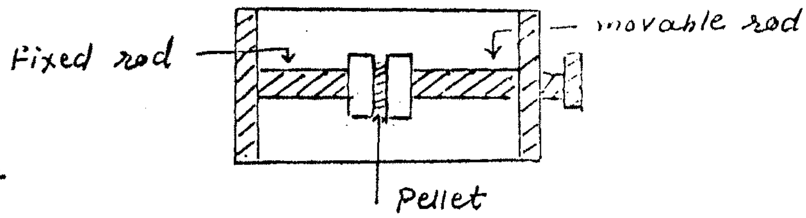

FIG.3.9 Crystal holder

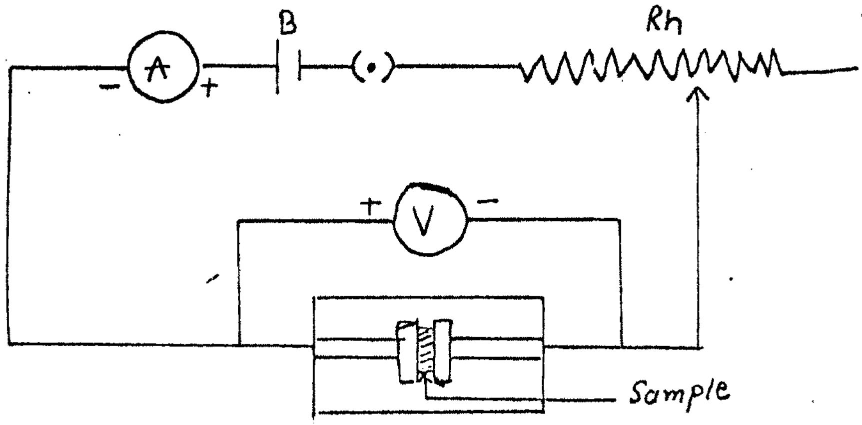

FIG.3.10
Measurement of current voltage.

cold water. These samples are used to prepare pellets. Initially, the powder was just mechanically blended in agete morter using acetone base. To prepare the pellet, about one gram of the powder was taken and few drops of polyvinyl acetate were added. It acts as a binder. The powder was introduced in to the hole of the die having one cm diameter Fig. (3.2). Hydraulic pressure of two tonnes/inch^2 was applied for two minutes.

The thickness of every pellet was measured after polishing, with the help of travelling microscope. These pellets are used to study I-V characteristic, d.c. conductivity and thermoelectric power.

3.2 X-RAY DIFFRACTION

The X-ray diffraction study is used to confirm the amorphous structure of the samples. Consider the notation of Kastner, Adler and Fritzsche for bond formation in Te-Te glass, [3.1].

$$/Te - Te\backslash \rightarrow /Te^{+} + :Te^{-}$$

Te^+ bonds itself with another $/Te\backslash$ or $/\ddot{Se}\backslash$ forming either Te_3^+ or Se_3^+ centre. When it forms Se_3^+ center by the reaction.

$$/Te^{+} + :Se< \rightarrow /Te - Se^{+}<$$

The total defect reaction becomes

$$Se_2^{\circ} + Te_2^{\circ} \rightarrow Se_3^{+} + Te_1^{-}$$

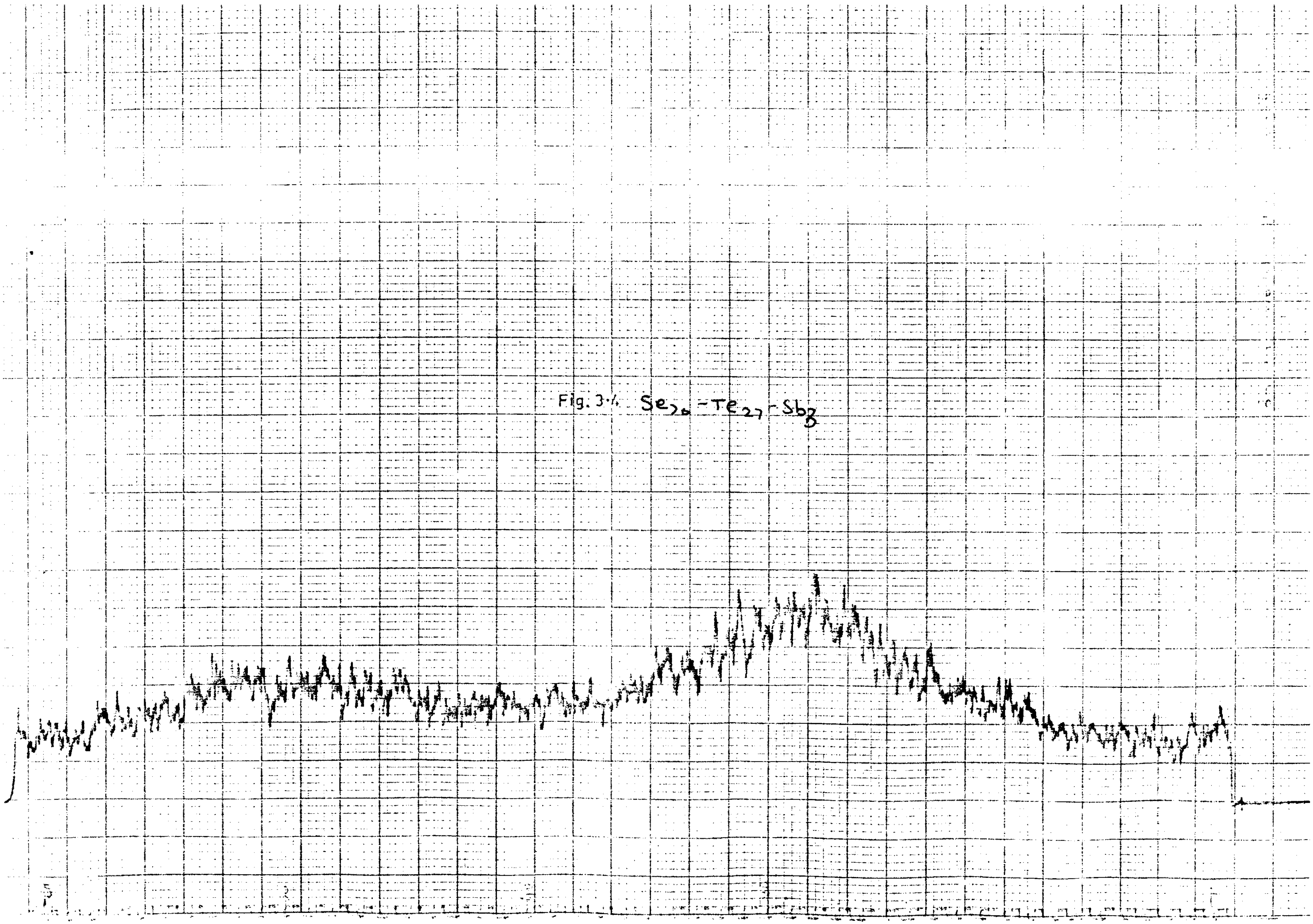

Fig. 3.4 Se_{70}-Te_{27}-Sb_{3}

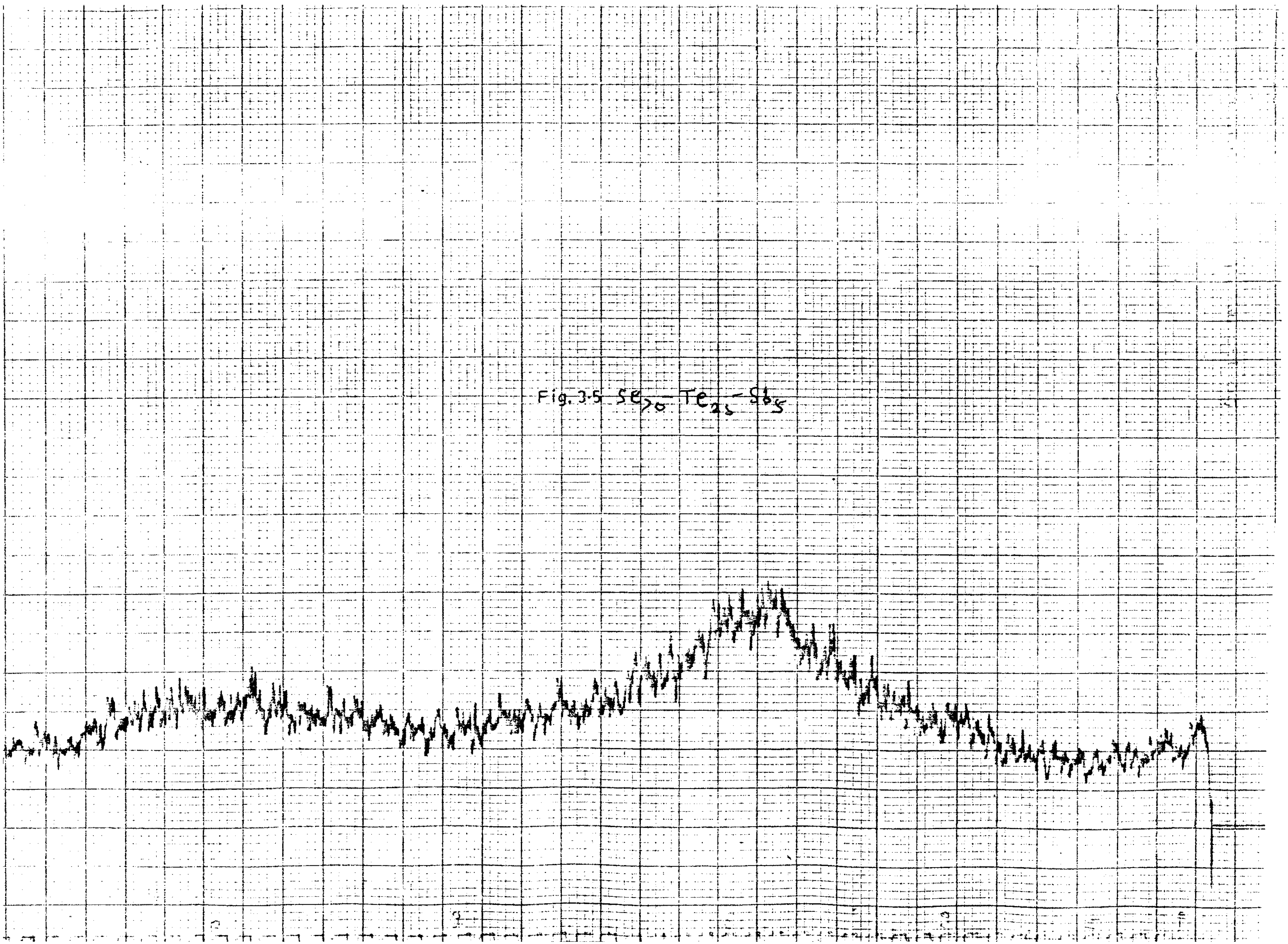

Fig. 3.5 $Se_{70}-Te_{25}-Sb_{5}$

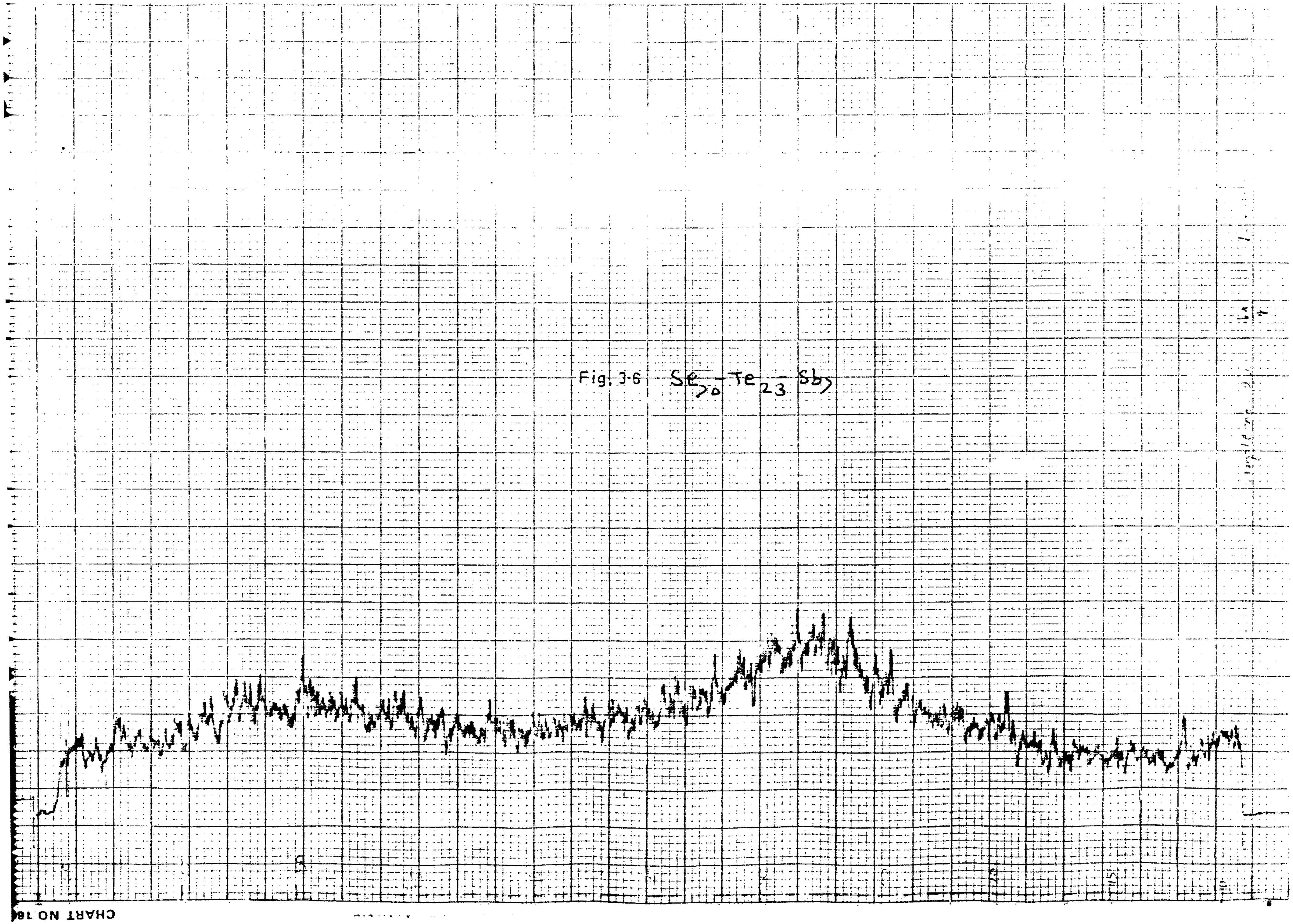

Fig. 3.6 $Se_{70} - Te_{23} - Sb_{7}$

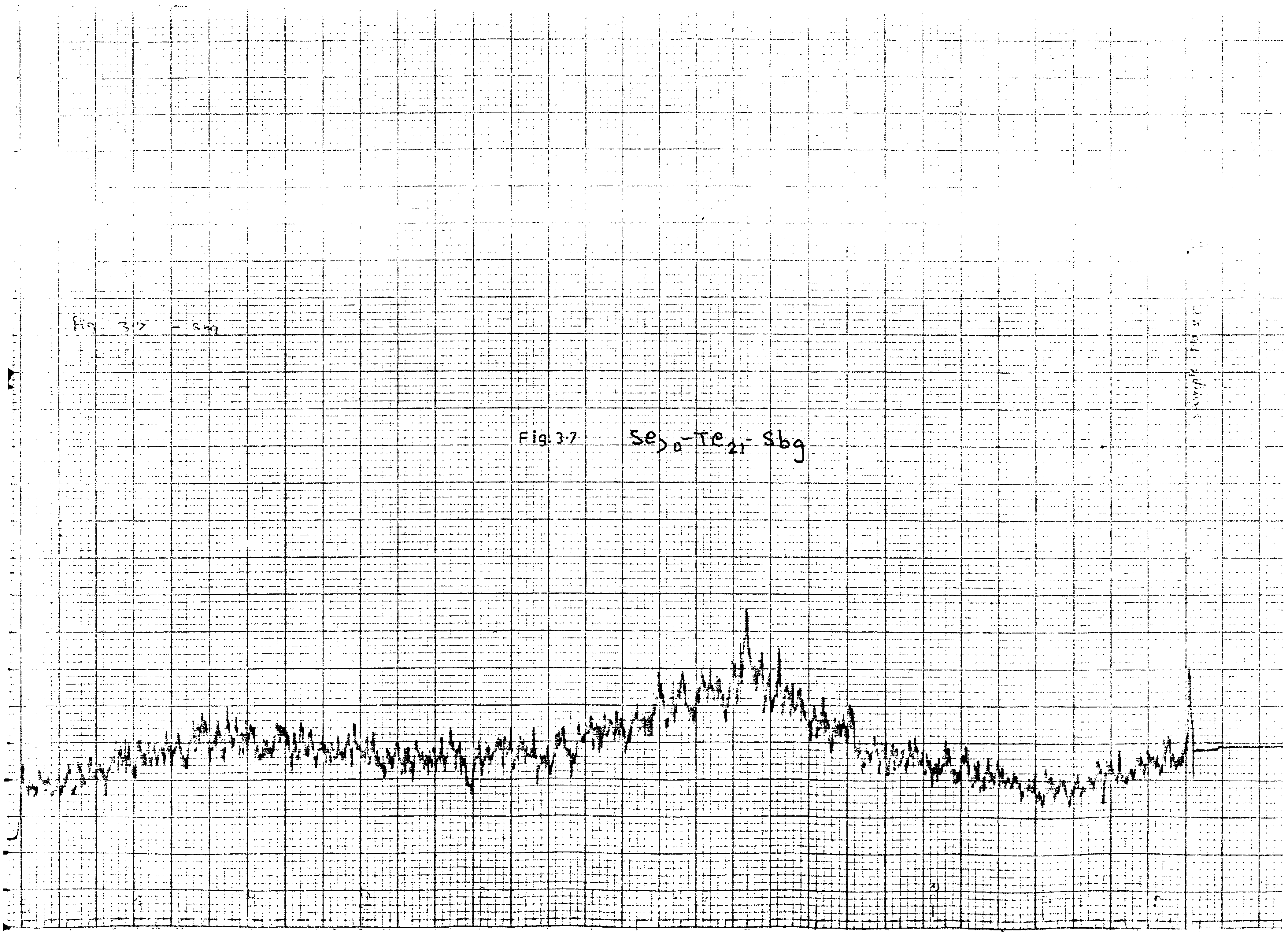

Fig. 3·7 Se_{70}-Te_{21}-Sb_9

The net result is that a weaker Te-Te bond is replaced by stronger Se-Te bond. The bond energy difference is recovered, and hence formation of the conjugate pair of defect namely Te_1^- and Se_3^+ require only lone pair energy. This defect model is discussed in chapter I.

To know the amorphous structure, sample was crushed into fine powder and the powder was taken on glass plate; to form a thin film of uniform thickness. The glass plate with powder is introduced in path of monocromatic beam of X-rays. Since the fine grains of the powder are randomly oriented the incident X-ray beam finds some plane which satisfies the Bragg Las [3.2,3.3]. In X-ray diffractometer a counter is mounted instead of photographic film. The counter gives graphical record, proportional to intensity of diffracted radiation. The X-ray diffraction patterns of the samples are shown in Fig.(3.3,3.8). We have used the Hitachi X-ray diffractometer at BARC. The ranges of angular changes were restricted between 10° to 60°. The rate of change of angular displacement of goniometer was adjusted to 2°/min. The voltage of 34 KV is applied, which produces a current of 18 mA across the instrument.

3.3 I-V CHARACTERISTICS :

For current voltage characteristics, a small thin circular pellet of thickness say example 0.2 cm and diameter 1 cm. is fitted on a crystal holder as shown in Fig.(3.9). The crystal holder consists of two small circular copper dises of perfectly smooth surface and some dimensions, one of the discs is in fixed position, while the other can be adjusted forward or backward. The pellet is fixed between these two dises as shown in above figure. The electrical circuit is shown in Fig.(3.10). The potential across the sample was applied from an electronically regulated power supply. The readings were taken at different concentrations and different thickness of the sampels. The potential up to 850 volt was applied across the sample with the help of requlated power supply. The current was noted with the help of a simpson multimeter (Rs.260 Simpson) The observations are reproducible and they are listed in tables (3.1) and (3.2). The current voltage characteristics are plotted for readings at room temperature, 27°C. These curves are shown in Fig.(3.11) and (3.12). The nature of curves is discussed in chapter IV.

Table No. 3.1

I-V for different concentration

Current Voltage (V) (Volts)	$Se_{70}Te_{30}$ μA	$Se_{70}Te_{29}Sb_1$ μA	$Se_{70}Te_{27}Sb_3$ μA	$Se_{70}Te_{25}Sb_5$ μA	$Se_{70}Te_{23}Sb_7$ μA	$Se_{70}Te_{21}Sb_9$ μA
50	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.10	0.15	0.0
150	0.0	0.10	0.15	0.20	0.50	0.0
200	0.05	0.15	0.25	0.40	0.85	0.05
250	0.10	0.25	0.50	0.75	1.00	0.10
300	0.25	0.50	0.75	1.25	1.85	0.15
350	0.40	0.75	1.00	1.75	2.25	0.20
400	0.60	1.00	1.25	2.25	2.75	0.25
450	0.85	1.25	1.75	2.70	3.25	0.40
500	1.120	1.50	2.10	3.15	3.75	0.50
550	1.40	1.75	2.50	3.60	4.25	0.70
600	1.75	2.15	2.90	4.10	4.75	0.90
650	2.00	2.50	3.40	4.65	5.50	1.25
700	2.40	3.00	3.75	5.20	6.00	1.75
750	2.85	3.50	4.5	5.75	6.50	2.50
800	3.25	4.00	5.0	6.00	7.25	3.50

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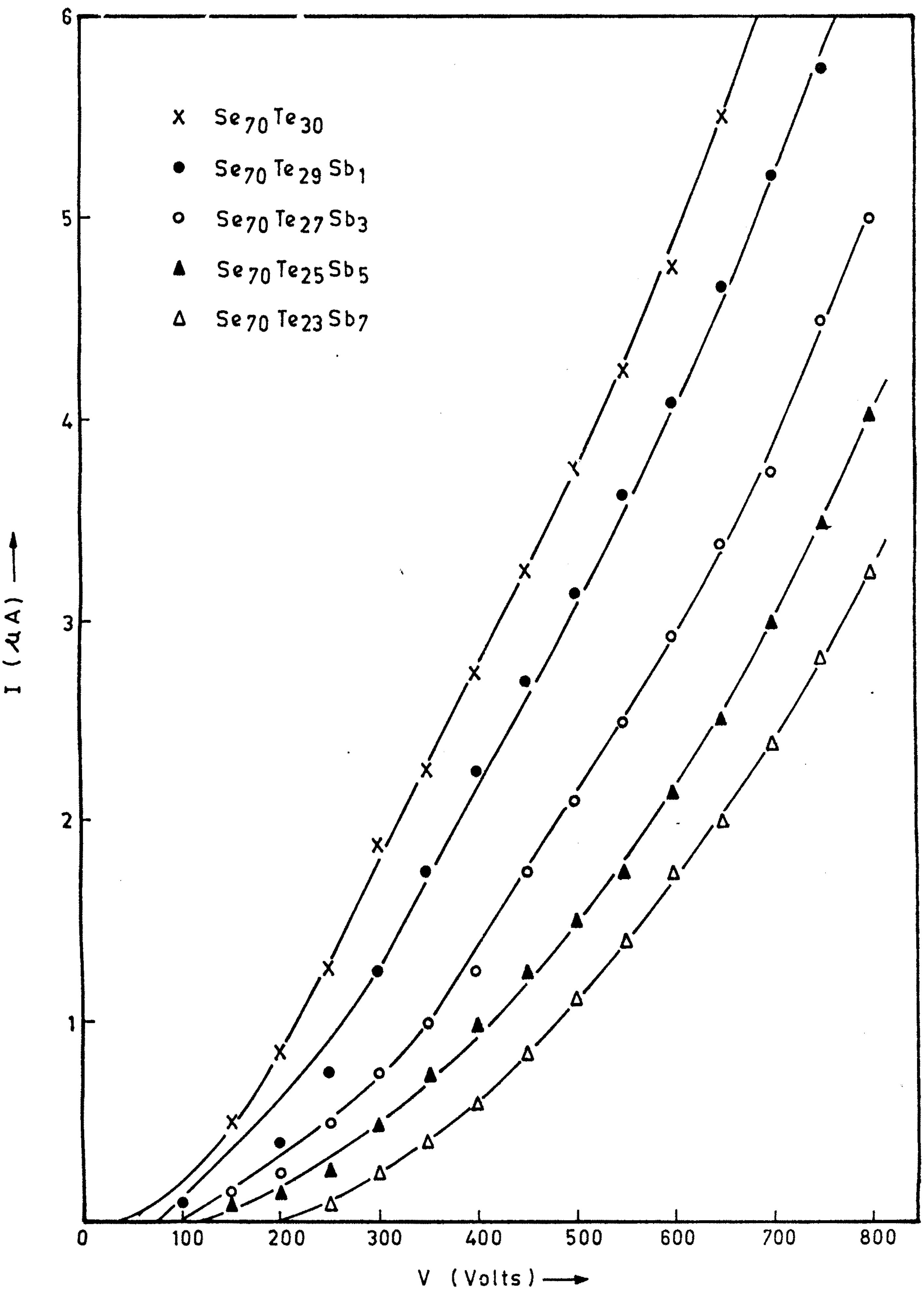
Table No. 3.2

I-V for different thickness

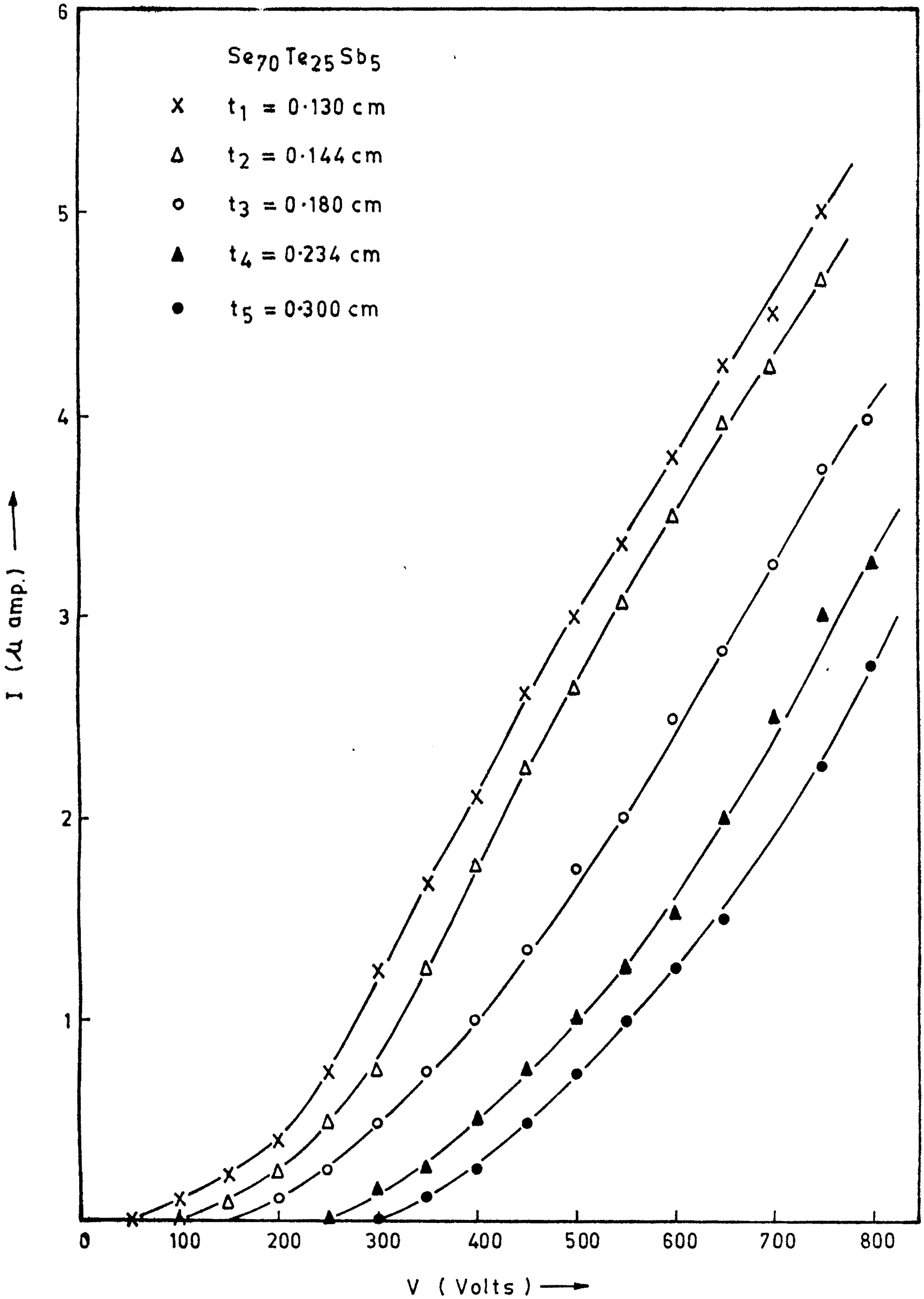
$Se_{70}Te_{25}Sb_5$

Current μA / Voltage (V) (Volts)	0.130 cm. μA	0.144 cm. μA	0.180 cm μA	0.234 cm μA	0.300 cm μA
50	0.0	0.0	0.0	0.0	0.0
100	0.10	0.0	0.0	0.0	0.0
150	0.20	0.10	0.0	0.0	0.0
200	0.40	0.25	0.10	0.0	0.0
250	0.75	0.50	0.25	0.0	0.0
300	1.25	0.75	0.50	0.15	0.0
350	1.65	1.25	0.75	0.25	0.15
400	2.10	1.75	1.35	0.50	0.25
450	2.60	2.25	1.50	0.75	0.50
500	3.00	2.65	1.75	1.00	0.75
550	3.40	3.05	2.00	1.25	1.00
600	3.80	3.50	2.50	1.50	1.25
650	4.25	4.00	2.80	2.00	1.50
700	4.50	4.25	3.25	2.50	2.00
750	5.00	4.75	3.75	3.00	2.25
800	6.00	5.00	4.00	3.25	2.75



6
5
4
3
2
1
0
100
200
300
400
500
600
700
800
I (μA) ⟶
V (Volts) ⟶
X Se70 Te30
● Se70 Te29 Sb1
○ Se70 Te27 Sb3
▲ Se70 Te25 Sb5
△ Se70 Te23 Sb7

Fig. 3·11



$Se_{70}Te_{25}Sb_5$
X $t_1 = 0{\cdot}130$ cm
Δ $t_2 = 0{\cdot}144$ cm
o $t_3 = 0{\cdot}180$ cm
▲ $t_4 = 0{\cdot}234$ cm
● $t_5 = 0{\cdot}300$ cm
I (μ amp.) ⟶
V (Volts) ⟶
0
1
2
3
4
5
6
100
200
300
400
500
600
700
800

Fig. 3·12

3.4 D.C. ELECTRICAL CONDUCTIVITY :

A flat circular pellet of thickness 0.2 cm and diameter 1 cm was fitted in the crystal holder. The whole arrangement is placed inside an electric furnace, so that external changes of temperature do not affect the sample. The experimental arrangement is shown in figure (3.13). The constant voltage of 10C volts is applied across the sample with the help of Aplab 7111 regulated power supply. The change in current across the sample was noted with the help of pla DM-14-B Ammeter at different temperatures. The temperature of the sample is recorded with the help of digital DC micro-voltmeter (Vasavi Electronics Secunderabed). The readings for each sample are listed in table (3.3 - 3.8).

From this value, the resistance, resistivity and conductivity is calculated using the following formula :

1) $R = V/I$ Where
V = Voltage applied.
I = Current across sample.
R = Resistance of sample.

2) $\rho = \frac{RA}{L}$
A = Cross sectional aera of sample.
L = Thickness of sample.

3) $\sigma = 1/\rho$
ρ = Resistivity of sample.
σ = Conductivity of sample.

The values of $\ln\sigma$, and (1/T) are listed in table (3.3-3.8). The graphs of $\ln\sigma$ Vs $10^3/T$ was plotted. The procedure was repeated for all samples. The curves are reproducible as shown in Fig.(3.14).

The conductivity is given by equation

$$\sigma = \sigma_0 \exp.\left(- \frac{E\sigma^*}{KT}\right)$$

Where

σ = Conductivity

σ_o = Constant

$E(\sigma^*)$ = Activation energy

$$\ln\sigma = \ln\sigma_o \left(- \frac{E\sigma^*}{KT}\right)$$

From the above equation

Slope $= E\sigma^*/k$

$E(\sigma^*)$ = Slope x k

= Slope x 0.8626 x 10^{-4} eV.

From the above equation, activation energy for each sample is calculated which is listed in table (4.1). The different graphs from conductivity are shown in figure (3.15 - 3.19).

The result of these graph are discussed in chapter IV.

TABLE NO. 3.3

D.C. Conductivity measurement of

$Se_{70}Te_{30}$

1) Applied Voltage = 100 volts.
2) Thickness of sample x = 0.16 cm.,
3) Area (πr^2) = 3.142 x $(0.5)^2$ = 0.7855 cm^2.
4) Room Temperature = 300°K.

$10^3/T$ /°K	Current μA	R = V/I Ω	ρ = RA/x Ω Cm	σ = 1/ρ $\Omega^{-1}Cm^{-1}$	lnσ $\Omega^{-1}Cm^{-1}$
3.3057	0.25	400.00 x 10^6	1963.72 x 10^6	5.09 x 10^{-10}	-21.39
3.2786	0.75	133.33 x 10^6	654.55 x 10^6	1.52 x 10^{-9}	-20.29
3.2520	1.50	66.66 x 10^6	327.25 x 10^6	3.05 x 10^{-9}	-19.60
3.2258	1.75	57.14 x 10^6	280.517 x 10^6	3.56 x 10^{-9}	-19.452
3.2000	2.25	44.44 x 10^6	218.169 x 10^6	4.58 x 10^{-9}	-19.200
3.1746	2.75	36.36 x 10^6	178.502 x 10^6	5.602 x 10^{-9}	-19.000
3.1496	3.00	33.33 x 10^6	163.626 x 10^6	6.111 x 10^{-9}	-18.913
3.1250	4.00	25.00 x 10^6	122.732 x 10^6	8.147 x 10^{-9}	-18.62
3.1007	5.00	20.00 x 10^6	98.186 x 10^6	1.018 x 10^{-8}	-18.402
3.0769	6.00	16.66 x 10^6	81.78 x 10^6	1.22 x 10^{-8}	-18.219
3.0534	6.75	14.81 x 10^6	72.706 x 10^6	1.375 x 10^{-8}	-18.101
3.0303	7.50	13.33 x 10^6	65.440 x 10^6	1.528 x 10^{-8}	-17.99
3.0075	10.00	10.00 x 10^6	49.093 x 10^6	2.036 x 10^{-8}	-17.70
2.9850	12.00	8.33 x 10^6	40.89 x 10^6	2.445 x 10^{-8}	-17.52
2.9629	14.00	7.142 x 10^6	35.05 x 10^6	2.852 x 10^{-8}	-17.37
2.9411	17.00	5.882 x 10^6	28.86 x 10^6	3.4642 x 10^{-8}	-17.17

Table No. 3.4

$Se_{70}Te_{29}Sb_1$

1) Applied Voltage V = 100 Volts.

2) Thickness of Pellet X = 0.160 cm.

3) Area = Πr^2 = 0.7855 cm^2.

4) Area/Thickness = A/X = 4.9093.

5) Room Temperature = 273 + 27 = 300°K.

$10^3/T$ $°K^{-1}$	Current I amp.	R = V/I Ω	ρ = RA/X Ω-cm	$\sigma = 1/\rho$ $\Omega^{-1}cm^{-1}$	$\ln\sigma$ $\Omega^{-1}cm^{-1}$
3.3057	0.50×10^{-6}	200.00×10^6	981.86×10^6	1.01×10^{-9}	-20.70
3.2786	1.00×10^{-6}	83.33×10^6	409.10×10^6	2.44×10^{-9}	-19.82
3.2520	1.50×10^{-6}	66.66×10^6	327.29×10^6	3.05×10^{-9}	-10.60
3.2258	1.75×10^{-6}	57.14×10^6	280.51×10^6	3.56×10^{-9}	-19.45
3.2000	2.00×10^{-6}	50.00×10^6	245.46×10^6	4.07×10^{-9}	-19.31
3.1746	2.75×10^{-6}	36.36×10^6	178.50×10^6	5.60×10^{-9}	-19.00
3.1496	3.50×10^{-6}	28.57×10^6	140.25×10^6	7.13×10^{-9}	-18.75
3.1250	4.50×10^{-6}	22.22×10^6	109.08×10^6	9.16×10^{-9}	-18.50
3.1007	6.00×10^{-6}	16.66×10^6	81.78×10^6	1.22×10^{-8}	-18.21
3.0769	7.0×10^{-6}	14.28×10^6	70.10×10^6	1.43×10^{-8}	-18.06
3.0534	9.0×10^{-6}	11.11×10^6	54.54×10^6	1.83×10^{-8}	-17.81
3.0303	10.0×10^{-6}	10.00×10^6	49.09×10^6	2.04×10^{-8}	-17.70
3.0075	12.5×10^{-6}	8.00×10^6	39.27×10^6	2.55×10^{-8}	-17.48
2.9850	15.0×10^{-6}	6.66×10^6	32.69×10^6	3.05×10^{-8}	-17.30
2.9629	19.0×10^{-6}	5.26×10^6	25.82×10^6	3.87×10^{-8}	-17.06
2.9411	21.0×10^{-6}	4.6×10^6	22.58×10^6	4.42×10^{-8}	-16.93

TABLE NO. 3.5

$Se_{70}Te_{27}Sb_3$

1) Voltage = 100 volts.

2) Thickness = 0.125 cm.

3) Area πr^2 = 0.7855

Area/Thick = 0.7855/0.125 = 6.284 cm.

4) Room Temperature = 300°K.

$10^3/T$ °K^{-1}	I Amp. x 10^{-6}	R = V/I x 10^6	ρ = RA/X x 10^6	σ = 1/ρ $\Omega^{-1}cm^{-1}$ x 10^{-9}	lnσ $\Omega^{-1}cm^{-1}$
3.3057	1.0	100.0	628.4	1.59	-20.25
3.2786	1.25	66.66	418.89	2.38	-19.85
3.2520	2.0	50.00	314.2	3.18	-19.56
3.2258	2.75	36.36	228.48	4.37	-19.24
3.2000	3.5	28.57	179.53	5.57	-19.00
3.1746	4.75	21.05	132.27	7.56	-18.70
3.1496	6.00	16.66	104.69	9.55	-18.46
3.1250	7.5	13.13	82.50	12.10	-18.22
3.1007	9.0	11.11	69.81	14.30	-18.06
3.0769	11.5	8.69	54.60	18.30	-17.81
3.0534	14.0	7.14	44.86	22.20	-17.61
3.0303	16.5	6.06	38.08	26.20	-17.45
3.0075	20.0	5.00	31.42	31.80	-17.26
2.9850	22.50	4.44	27.90	35.80	-17.14
2.9629	25.50	3.92	24.63	40.60	-17.01
2.9411	27.00	3.70	23.25	43.00	-16.96

TABLE NO. 3.6

$Se_{70}Te_{25}Sb_5$

1) Voltage = 100 volts.
2) Thickness x = 0.130 cm.
3) Area πr^2 = 0.7855 cm^2.
4) Area/Thickness = 6.042 cm.
5) Temperature (Room) = 300°K.

$10^3/T$ /°K	Current I Amp. x 10^{-6}	R = V/I Ω x 10^6	ρ = RA/x x 10^6	σ = 1/ρ $\Omega^{-1}Cm^{-1}$ x 10^{-9}	lnσ $\Omega^{-1}cm^{-1}$
3.3057	1.75	57.14	354.23	2.89	-19.65
3.2786	2.25	44.44	268.50	3.72	-19.40
3.2520	3.00	33.33	201.37	4.96	-19.12
3.2258	4.00	25.00	151.05	6.62	-18.83
3.2000	5.50	18.18	109.84	9.104	-18.51
3.1746	8.00	12.50	75.52	13.20	-18.13
3.1496	10.00	10.00	60.42	16.50	-17.91
3.1250	12.00	8.33	50.32	19.80	-17.73
3.1007	15.00	6.66	40.23	24.80	-17.51
3.0769	18.00	5.55	33.53	29.80	-17.32
3.0534	21.00	4.76	28.75	34.70	-17.17
3.0303	25.00	4.00	24.16	41.30	-17.00
3.0075	29.00	3.44	20.78	48.10	-16.84
2.9850	32.00	3.12	18.85	53.00	-16.75
2.9629	35.00	2.85	17.21	58.10	-16.66
2.9414	39.00	2.56	15.46	64.60	-16.55

Table No. 3.7

$Se_{70}Te_{23}Sb_7$

1) Voltage = 100 Volts.

2) Thickness X = 0.125 cm.

3) Area πr^2 = 0.7855 cm^2.

4) Area/Thick = 6.284.

5) Room Temperature = 300°K.

$10^3/T$ /°K	Current I amp. x 10^{-6}	R = V/I Ω x 10^6	ρ = RA/x x 10^6	σ = 1/ρ $\Omega^{-1} cm^{-1}$ x 10^{-9}	lnσ $\Omega^{-1} cm^{-1}$
3.3057	2.00	50.00	314.20	3.18	-19.56
3.2786	2.50	40.00	251.36	3.97	-19.34
3.2520	3.50	28.57	179.53	5.57	-19.00
3.2258	4.50	22.22	139.63	7.16	-18.75
3.2000	6.00	16.66	104.69	9.55	-18.46
3.1746	9.00	11.11	69.81	14.32	-18.06
3.1496	11.00	9.09	57.12	17.50	-17.86
3.1250	13.50	7.40	46.50	21.50	-17.65
3.1007	16.00	6.25	39.27	25.40	-17.48
3.0769	19.00	5.26	33.05	30.20	-17.31
3.0534	22.00	4.54	28.52	35.00	-17.16
3.0303	26.00	3.84	24.13	41.40	-16.99
3.0075	30.00	3.33	20.92	47.80	-16.85
2.9850	33.00	3.03	19.04	52.50	-16.76
2.9629	36.00	2.77	17.40	57.40	-16.67
2.9411	40.00	2.50	15.71	63.60	-16.56

Table No. 3.8

$Se_{70}Te_{21}Sb_9$

1) Applied Voltage V = 100 Volts.

2) Thickness of the Pellet = 0.125 cm.

3) Area πr^2 = 0.7853 cm^2.

4) Area/Thickness = 6.284 cm.

5) Room Temperature = (223 + 27) = 300°K.

$10^3/T$ $^\circ K^{-1}$	Current I amp. 10^{-6}	R = V/I Ω 10^6	ρ = RA/x 10^6	$\sigma = 1/\rho$ $\Omega^{-1}cm^{-1}$ 10^{-9}	ln σ $\Omega^{-1}cm^{-1}$
3.3057	0.25	400.00	2 513.60	0.397	-21.64
3.2786	0.50	200.00	1 256.80	0.795	-20.95
3.2520	1.00	100.00	628.40	1.59	-20.25
3.2258	1.50	66.66	418.89	2.38	-19.85
3.2000	2.50	40.00	251.36	3.97	-19.34
3.1746	3.50	28.57	179.53	5.57	-19.00
3.1496	4.00	25.00	157.10	6.36	-18.87
3.1250	5.25	19.04	119.64	8.35	-18.59
3.1007	6.75	14.81	93.06	10.70	-18.34
3.0769	8.00	12.50	78.55	12.70	-18.17
3.0534	10.00	10.00	62.84	15.90	-17.95
3.0303	12.25	8.16	51.27	19.50	-17.75
3.0075	15.00	6.66	41.85	23.80	-17.54
2.9850	17.00	5.88	36.94	27.00	-17.42
2.9629	20.00	5.00	31.42	31.80	-17.26
2.9411	22.00	4.54	28.52	35.00	-17.16

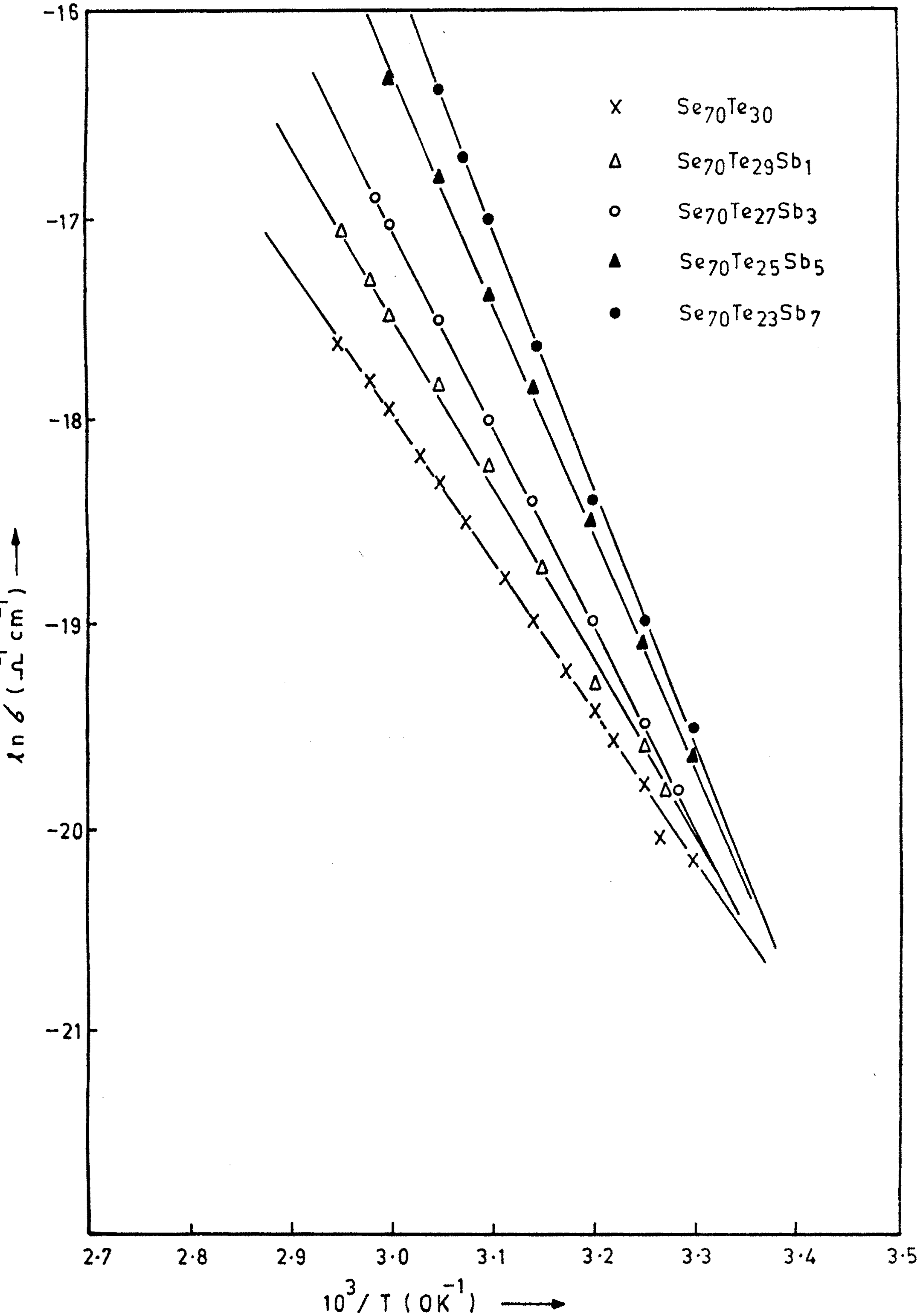

-16
-17
-18
-19
-20
-21
2·7
2·8
2·9
3·0
3·1
3·2
3·3
3·4
3·5
$\ln \sigma$ (Ω^{-1} cm^{-1}) ⟶
10^3/ T (0K^{-1}) ⟶
X $Se_{70}Te_{30}$
Δ $Se_{70}Te_{29}Sb_1$
○ $Se_{70}Te_{27}Sb_3$
▲ $Se_{70}Te_{25}Sb_5$
● $Se_{70}Te_{23}Sb_7$

Fig. 3·13

3.5 THERMOELECTRIC POWER :

To determine thermoelectric power of a given amorphous sample, hot and cold junction arrangement was made as shown in Fig.(3.2). The sample of thickness 0.20 cm. and diameter 1 cm is fixed in between two brass rods of equal dimensions. To know the temperature difference between hot and cold junctions thermocouple (Alumel,Chromel) was used, keeping one end of sample cold and other end hot by heating the rod. The temperature across the hot junction was measured in mV by DM-14-B meter (PLA : Electronic, Bombay). The temperature across the cold end was measured with digital dc microvoltmeter. (Vasavi Electronic Secanderabad). The thermo e.m.f. developed across the sample was measured with the help of microvoltmeter. The temperature of hot end is varied up to 50°C and corresponding temperature of cold junction and thermo e.m.f. developed across the sample was noted. The temperature of hot and cold junction is converted in to degree Kelvin with the help of conversion factor (1mV = 25°C).

The observations for each sample are listed in table (3.9 to 3.14). The graph of ΔV against ΔT is plotted as shown in figure (3.21).

Using formula $s = \Delta V/\Delta T$, thermoelectric power can be calculats.

Where S = theroelectric power.

The graph between S and 1/T is shown in Fig. (3.22). The nature of the graph is linear and from this graph we calculate the activation energy using

$$S = \frac{\Delta V}{\Delta T} = \frac{k}{e} \left[\frac{Es^{*}}{KT} + A \right]$$

$$= \frac{k}{e} \left[\frac{Es^{*}}{KT} + 1 \right] \quad \text{Where } A = 1.$$

$$= \frac{Es^{*}}{e} \quad \frac{1}{T}$$

This equation gives

$$\text{Slope} = \frac{Es^{*}}{e}$$

$$Es^{*} = \text{Slope} \times e$$

Where E_s^{*} is activation energy calculated by using thermoelectric power. The graph of Q(T) against 1/T gives value of Q_o. The graph of $\ln\sigma$ against S yields value of σ_o. The values are listed in table (3.15 - 3.17) and (4.1).

We know the equations, [3.7], [3.8], [3.9].

$$Q(T) = \ln\sigma\ (T) + \frac{q}{k}\ S(T)$$

$$Q(T) = Q_o - \frac{E_Q}{kT}$$

and

$$\sigma_o = 0.03 \frac{e^2}{h^2}\ l_1$$

$$= 0.03 \times \frac{q^2 \Pi 4^{\ 2}}{h^2}\ l_1$$

$$\sigma(0) = 0.8806 \times 10^{8}\ l_1$$

$$l_1 = \sigma o \times 1.355 \times 10^{-8}\,\text{cm.}$$

Where l_1 = is inelastic diffusion length.

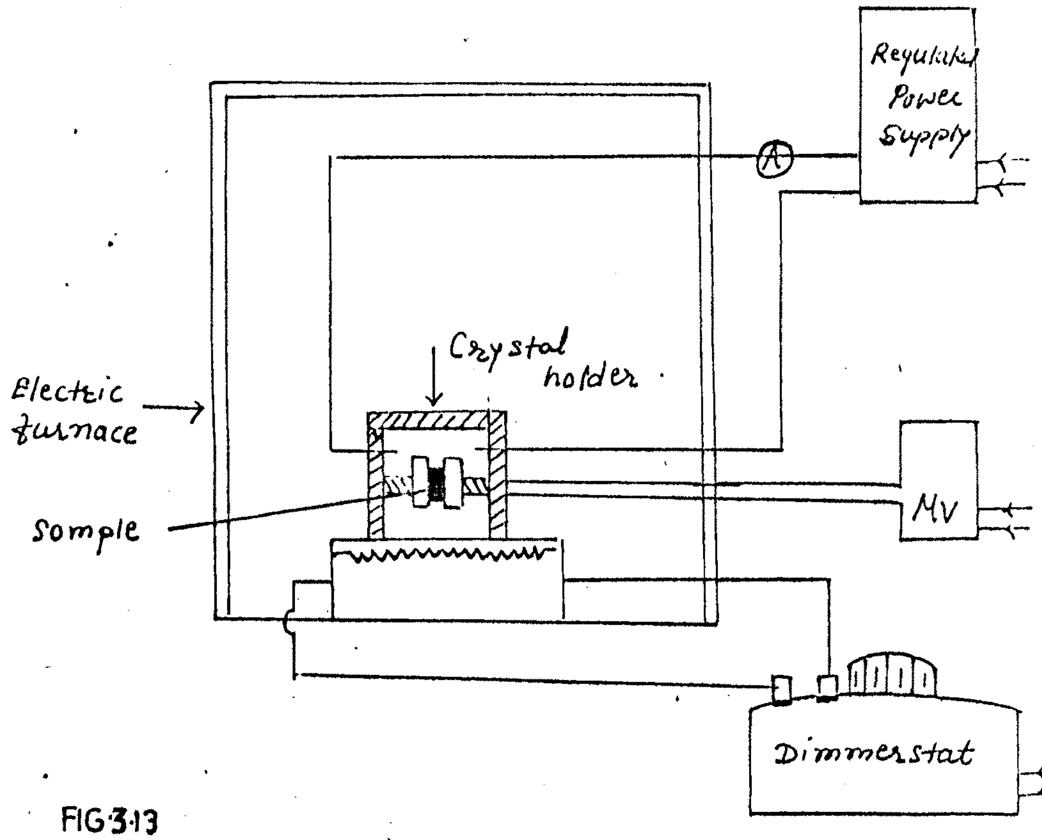


FIG 3.13

Experimental set up for measurement of d.c. conductivity.

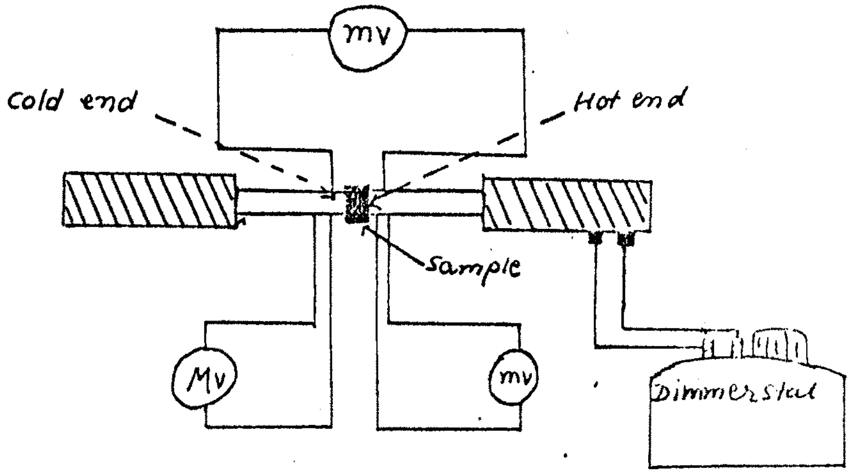


FIG 3.20

Experimental set up for measurement of thermoelectric power.

Table No. 3.9

$Se_{70}Te_{30}$

Thermo-electric measurement.

Temp. of One end T_1 °C	Temp. of Other end T_2 °C	ΔT (°C)	ΔV (mV)	$T = T_1 - \Delta T/2$	$\frac{10^3}{T}$ /°K^{-1}	$S = \Delta V/\Delta T$ (mV K^{-1})
32	29.5	2.5	4.45	303.75	3.292	1.78
37	32.0	5.0	8.64	307.50	3.252	1.728
42	34.5	7.5	12.62	311.25	3.212	1.682
47	37.0	10.0	16.40	315.00	3.174	1.640
52	39.0	12.5	20.00	318.75	3.137	1.600
57	42.0	15.0	23.40	322.5	3.100	1.560
62	44.5	17.5	26.60	326.25	3.065	1.520
67	47.0	20.0	29.75	330.0	3.030	1.487

Table No. 3.10

Thermo-electric measurement of

$Se_{70}Te_{29}Sb_1$

Temp. of One end T_1 °C	Temp. of Other end T_2 °C	ΔT (°C)	ΔV (mV)	$T = T_1 - \Delta T/2$	$\frac{10^3}{T}$ /°K	$S = \Delta V/\Delta T$ (mV K^{-1})
32	29.5	2.5	5.008	303.75	3.292	1.778
37	32.0	5.0	10.00	307.50	3.252	1.729
42	34.5	7.5	14.00	311.25	3.212	1.683
47	37.0	10.0	17.312	315.00	3.174	1.640
52	39.5	12.5	20.218	318.75	3.137	1.598
57	42.0	15.0	25.601	322.5	3.100	1.558
62	44.5	17.5	28.320	326.25	3.065	1.521
67	47.0	20.0	32.101	330.0	3.030	1.486

Table No. 3.11

Thermo-electric measurement of

$Se_{70}Te_{27}Sb_3$.

Temp. of One end T_1°C	Temp. of Other end T_2°C	ΔT (°C)	ΔV (mV)	$T = T_1 - \Delta T/2$	$\frac{10^3}{T}$/°K	$S = \Delta V/\Delta T$ (mV K^{-1})
32	29.5	2.5	5.308	303.75	3.292	2.123
37	32.0	5.0	10.825	307.50	3.252	2.065
42	34.5	7.5	15.076	311.25	3.212	2.010
47	37.0	10.0	19.529	315.00	3.174	1.957
52	39.5	12.5	23.853	318.75	3.137	1.908
57	42.0	15.0	27.918	322.5	3.100	1.861
62	44.5	17.5	31.796	326.25	3.065	1.816
67	47.0	20.0	35.491	330.0	3.030	1.774

Table No. 3.12

Thermo-electric measurement of

$Se_{70}Te_{25}Sb_5$

Temp. of One end T_1 °C	Temp. of Other end T_2 °C	ΔT (°C)	ΔV (mV)	$T = T_1 - \Delta T/2$	$\frac{10^3}{T}$/°K	$S = \Delta V/\Delta T$ (mV K^{-1})
32	29.5	2.5	6.007	303.75	3.292	2.402
37	32.0	5.0	11.685	307.50	3.252	2.337
42	34.5	7.5	17.062	311.25	3.212	2.274
47	37.0	10.0	22.158	315.00	3.174	2.215
52	39.5	12.5	26.995	318.75	3.137	2.159
57	42.0	15.0	31.597	322.50	3.100	2.106
62	44.5	17.5	35.984	326.25	3.065	2.056
67	47.0	20.0	40.166	330.00	3.030	2.008

Table No. 3.13

Thermo-electric measurement of

$Se_{70}Te_{27}Sb_7$.

Temp. of One end T_1°C	Temp. of Other end T_2°C	ΔT (°C)	ΔV (mV)	$T = T_1 - \Delta T/2$	$\frac{10^3}{T}$/°K	$S = \Delta V/\Delta T$ ($mV\ K^{-1}$)
32	29.5	2.5	6.563	303.75	3.292	2.625
37	32.0	5.0	12.767	307.50	3.252	2.553
42	34.5	7.5	18.641	311.25	3.212	2.485
47	37.0	10.0	24.208	315.00	3.174	2.420
52	39.5	12.5	29.493	318.75	3.137	2.359
57	42.0	15.0	34.520	322.50	3.100	2.301
62	44.5	17.5	39.313	326.25	3.065	2.246
67	47.0	20.0	43.882	330.0	3.030	2.194

Table No. 3.14

Thermo-electric measurement of

$Se_{70}Te_{21}Sb_{9}$.

Temp. of One end T_1°C	Temp. of Other end T_2°C	ΔT (°C)	ΔV (mV)	$T = T_1 - \Delta T/2$	$\frac{10^3}{T}$/°K	$S = \Delta V/\Delta T$ ($mV\ K^{-1}$)
32	29.5	2.5	4.896	303.75	3.292	1.958
37	32.0	5.0	9.523	307.50	3.252	1.904
42	34.5	7.5	13.905	311.25	3.212	1.854
47	37.0	10.0	18.058	315.00	3.174	1.805
52	39.5	12.5	22.000	318.75	3.137	1.760
57	42.0	15.0	25.750	322.5	3.100	1.716
62	44.5	17.5	29.326	326.25	3.065	1.675
67	47.0	20.0	32.735	330.00	3.030	1.636

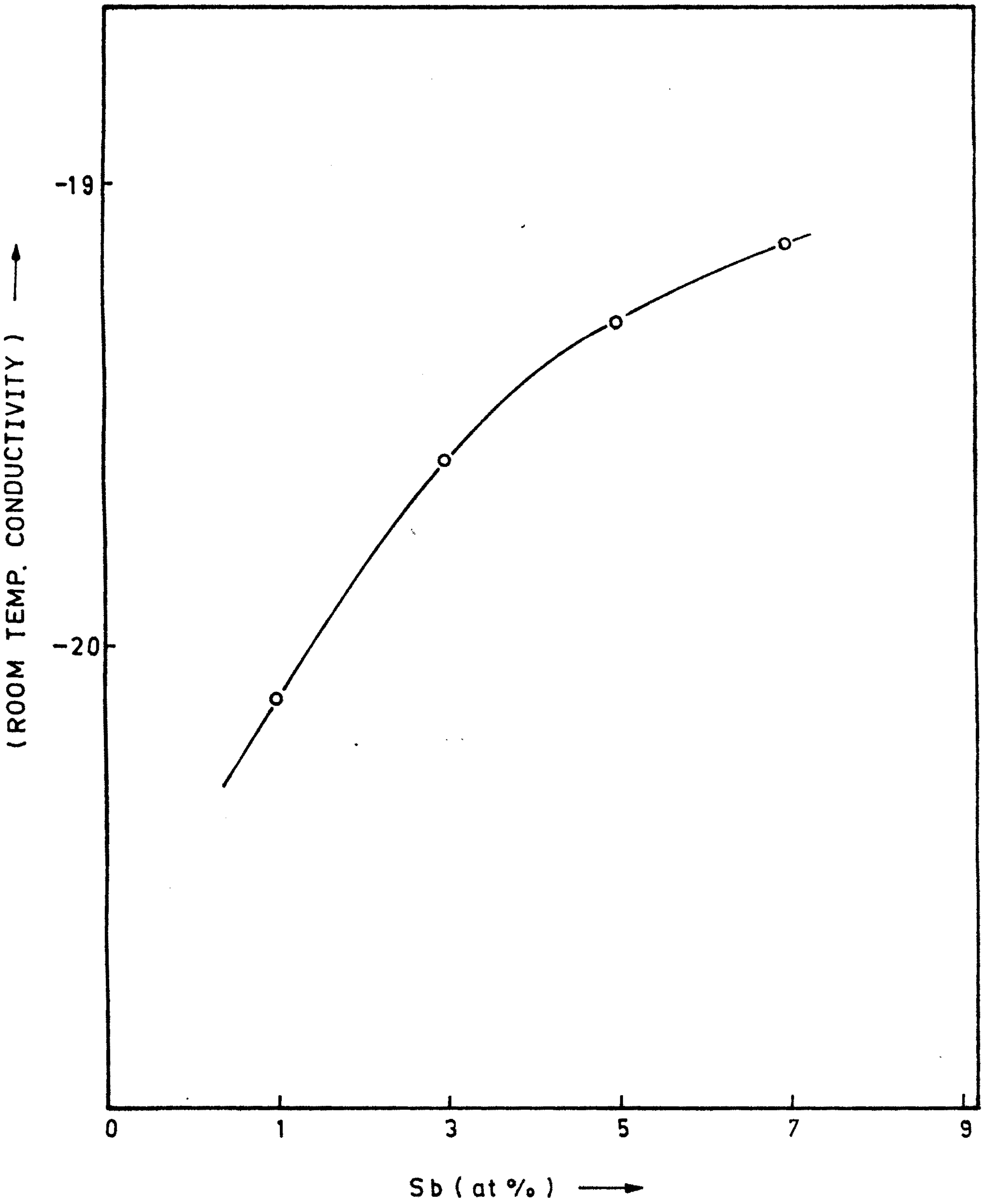


Fig. 3-14

Table No. 3.15

$Se_{70}Te_{30}$

$\frac{10^3}{T}$/°K	lnσ(T) $\Omega^{-1}cm^{-1}$	S(T) mV/°K	Q_T=lnσ(T)+11.608 x S(T)
3.298	-20.29	1.780	0.3722
3.252	-19.60	1.728	0.3657
3.212	-19.45	1.682	0.0746
3.174	-19.000	1.640	0.0371
3.137	-18.766	1.600	-0.1932
3.100	-18.40	1.560	-0.2915
3.065	-18.150	1.520	-0.5058
3.030	-17.99	1.487	-0.810

$Se_{70}Te_{29}Sb_1$

$\frac{10^3}{T}$/°K	lnσ(T) $\Omega^{-1}cm^{-1}$	S(T) mV/°K	Q_T= lnσ(T)+11.608 x S(T)
3.298	-19.82	1.778	0.819
3.252	-19.60	1.729	0.470
3.212	-19.45	1.683	0.086
3.174	-19.00	1.640	0.037
3.137	-18.25	1.598	0.299
3.100	-18.21	1.558	-0.1247
3.065	-17.48	1.521	0.1757
3.030	-17.35	1.486	-0.1005

Table No. 3.16

$Se_{70}Te_{70}Sb_3$

$\frac{10^3}{T}$ /°K	lnσ(T) Ω^{-1} cm^{-1}	S(T) mV/°K	Q = lnσ(T)+11.608 x S(T)
3.298	-19.85	2.123	4.7937
3.252	-19.56	2.065	4.4105
3.212	-19.24	2.010	4.0920
3.174	-18.70	1.957	4.0168
3.137	-18.22	1.908	3.9280
3.100	-18.06	1.861	3.5424
3.065	-17.26	1.816	3.8201
3.030	-17.15	1.774	3.442

$Se_{70}Te_{25}Sb_5$

$\frac{10^3}{T}$ /°K	lnσ(T) Ω^{-1} cm^{-1}	S(T) mV/°K	Q =lnσ(T)+11.608 x S(T)
3.292	-19.40	2.402	8.482
3.252	-19.12	2.337	8.0078
3.212	-18.83	2.274	7.5665
3.174	-18.13	2.215	7.5817
3.137	-17.91	2.159	7.1516
3.100	-17.51	2.106	6.9364
3.065	-17.10	2.056	6.7660
3.030	-16.84	2.008	6.4688

TABLE NO. 3.17

$Se_{70}Te_{23}Sb_7$

$\frac{10^3}{T}$ /°K	lnσ(T) Ω^{-1} cm^{-1}	S(T) mV/°K	QT= lnσ(T)+11.608 x S(T)
3.292	-19.34	2.625	11.1310
3.252	-19.00	2.553	10.6350
3.212	-18.75	2.485	10.0950
3.174	-18.06	2.420	10.0310
3.137	-17.86	2.359	9.5232
3.100	-17.48	2.301	9.2300
3.065	-16.85	2.246	9.2210
3.030	-16.76	2.194	8.7079

$Se_{70}Te_{21}Sb_9$

$\frac{10^3}{T}$ /°K	lnσ(T) Ω^{-1} cm^{-1}	S(T) mV/°K	QT= lnσ(T)+11.608 x S(T)
3.292	-20.95	1.958	1.7784
3.252	-20.25	1.904	1.8516
3.212	-19.85	1.854	1.6712
3.174	-19.00	1.805	1.9524
3.137	-18.87	1.760	1.5600
3.100	-18.34	1.716	1.5793
3.065	-17.54	1.675	1.9030
3.030	-17.42	1.636	1.5706

TABLE NO. 3.18

Sample	Inelastic Diffusion length (m)	$\sigma_0\ \Omega^{-1}cm^{-1}$	Qo
$Se_{70}Te_{30}$	8.59×10^{-10}	6.43	8.55
$Se_{70}Te_{29}Sb_1$	7.63×10^{-10}	5.71	7.94
$Se_{70}Te_{27}Sb_3$	10.16×10^{-10}	7.61	6.25
$Se_{70}Te_{25}Sb_5$	7.01×10^{-10}	5.25	3.50
$Se_{70}Te_{23}Sb_7$	7.13×10^{-10}	5.34	2.78
$Se_{70}Te_{21}Sb_9$	-	-	-

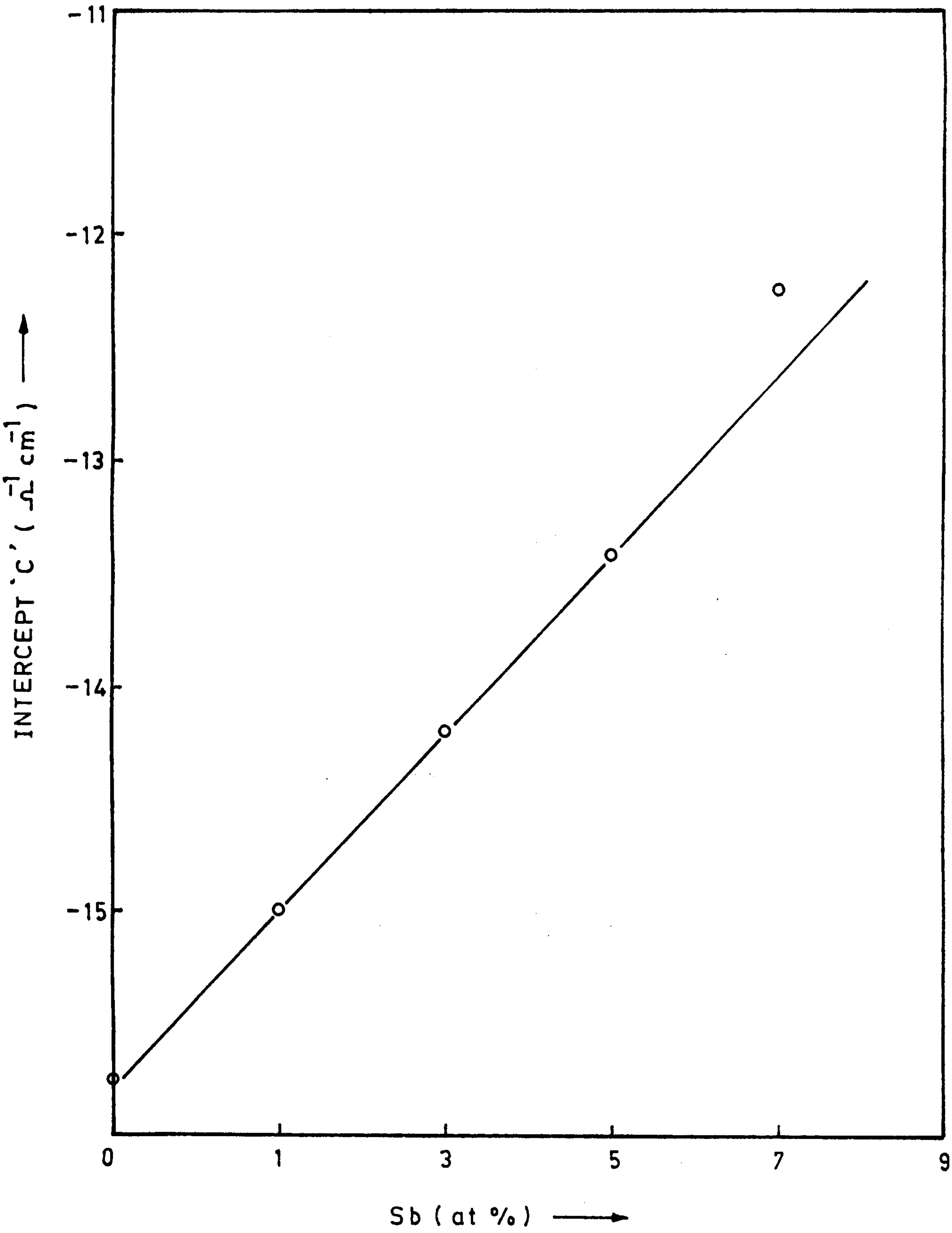
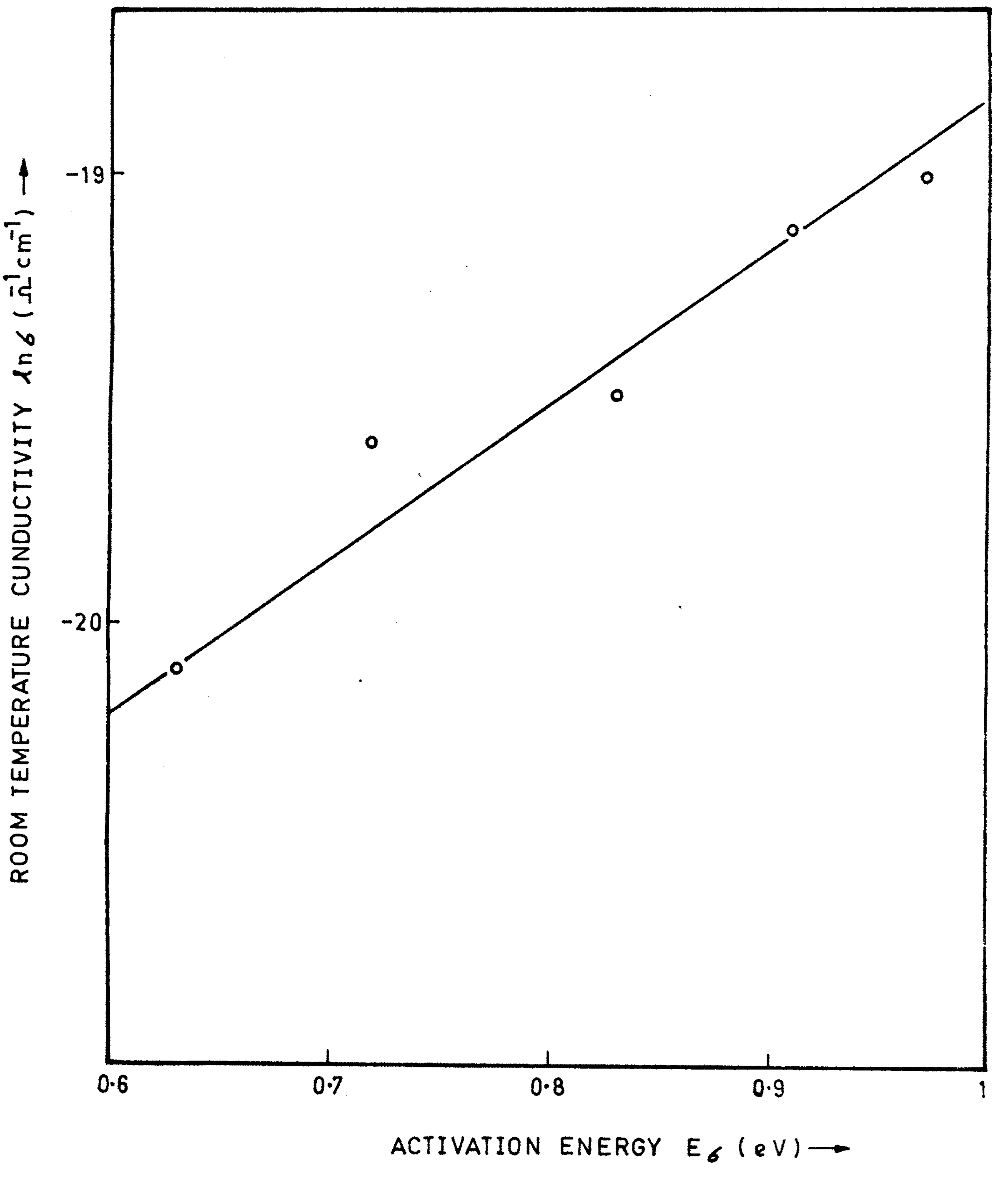
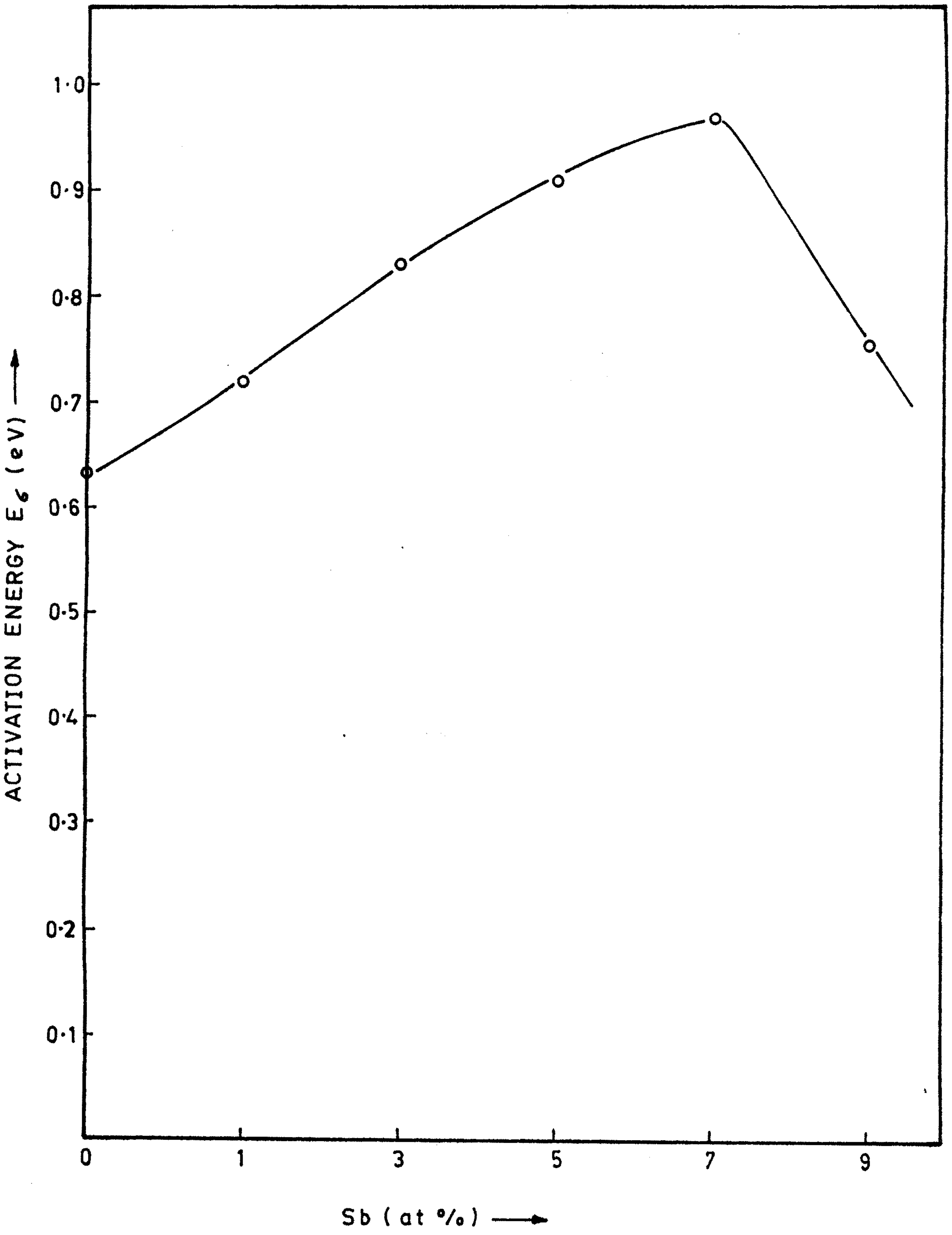


Fig. 3·15



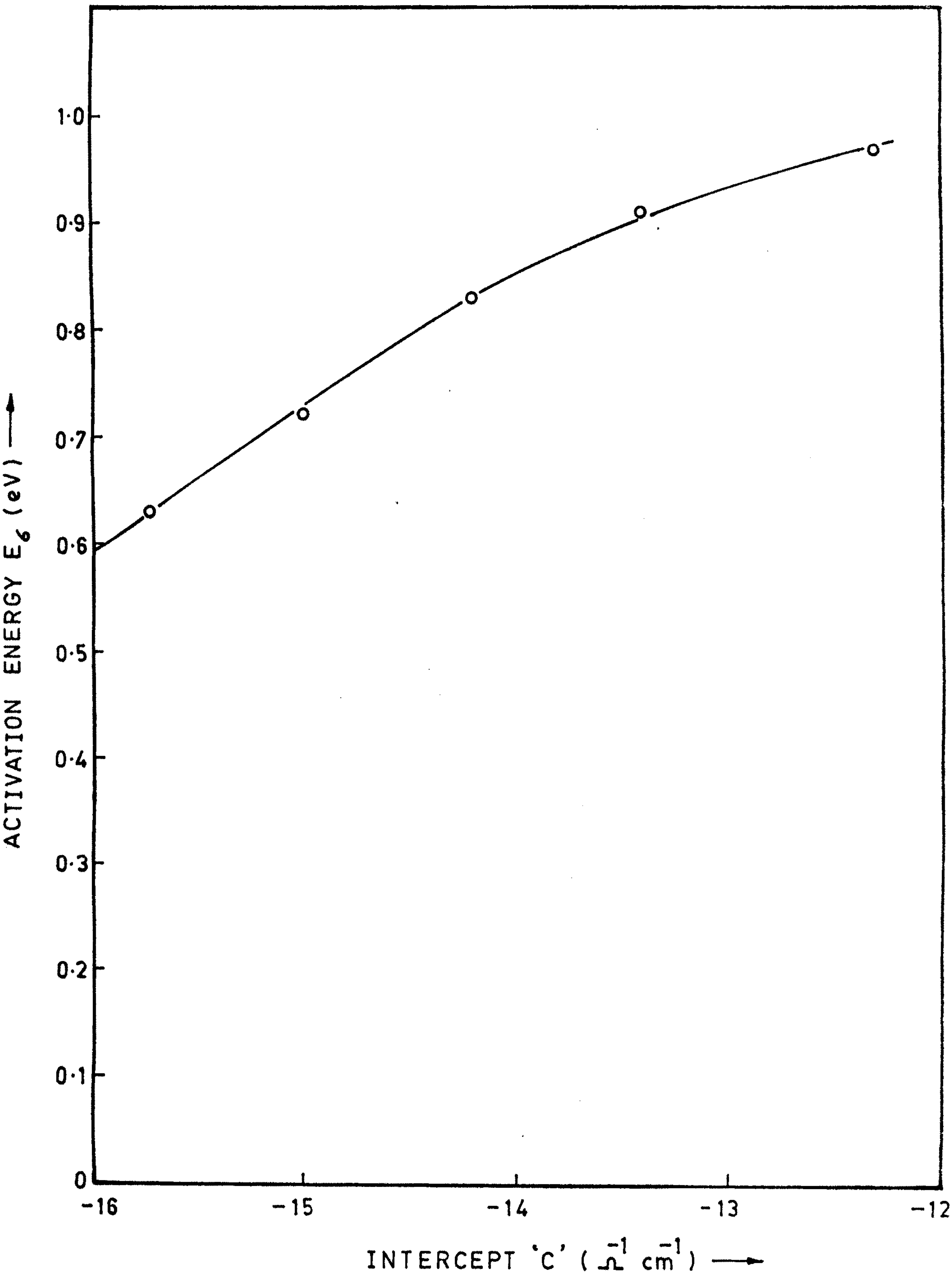
ROOM TEMPERATURE CUNDUCTIVITY $\ln\sigma$ ($\Omega^{-1}cm^{-1}$) →
-19
-20
0·6
0·7
0·8
0·9
1
ACTIVATION ENERGY E_σ (eV) →

Fig. 3·16



1·0
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
ACTIVATION ENERGY E_6 (eV)
0
1
3
5
7
9
Sb (at %)

Fig. 3·17



ACTIVATION ENERGY E_6 (eV)
1·0
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
0
−16
−15
−14
−13
−12
INTERCEPT 'C' (Ω^{-1} cm^{-1})

Fig. 3·18

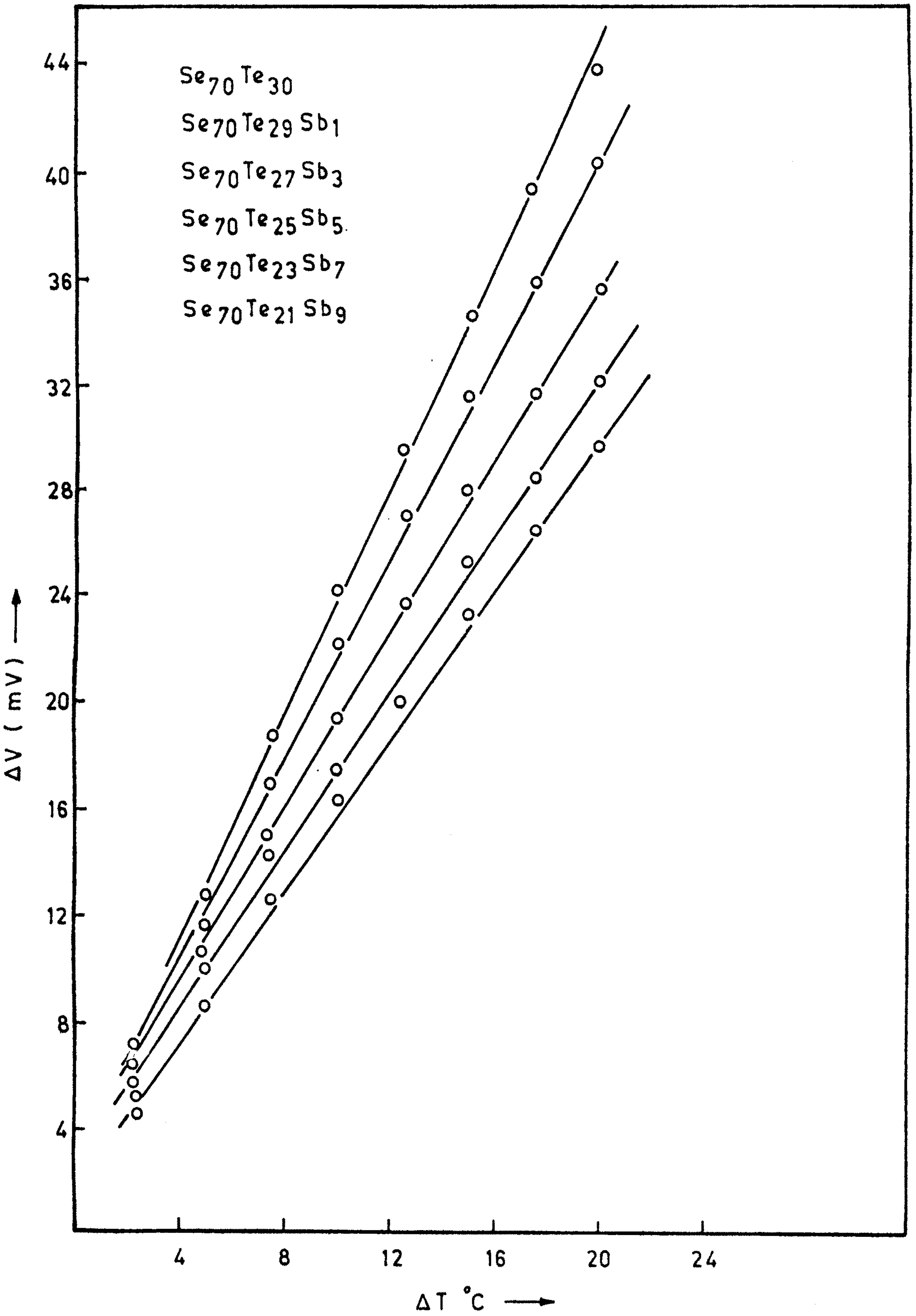

Se70 Te30
Se70 Te29 Sb1
Se70 Te27 Sb3
Se70 Te25 Sb5
Se70 Te23 Sb7
Se70 Te21 Sb9
ΔV (mV)
ΔT °C
44
40
36
32
28
24
20
16
12
8
4
4
8
12
16
20
24

Fig. 3-21

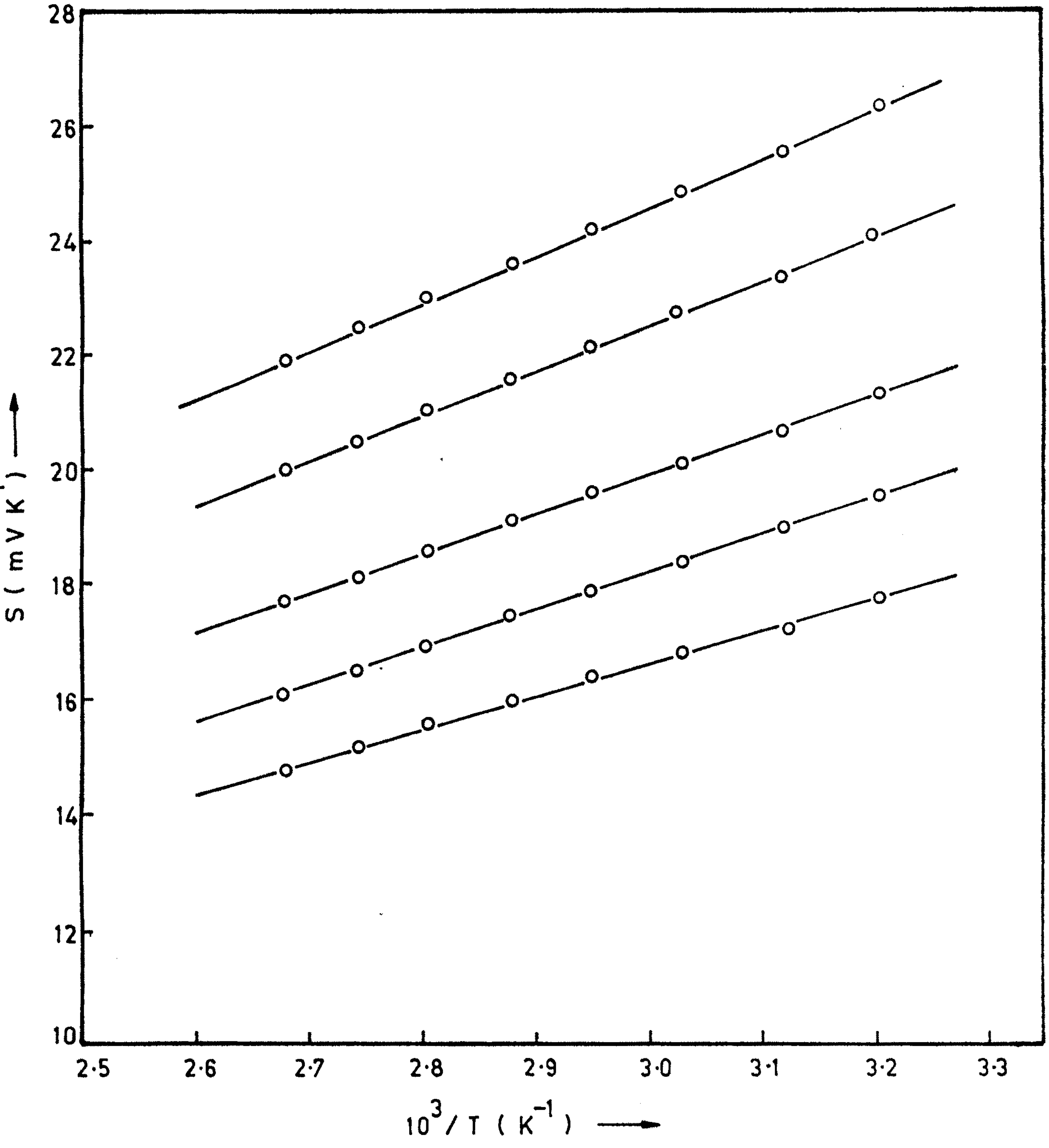
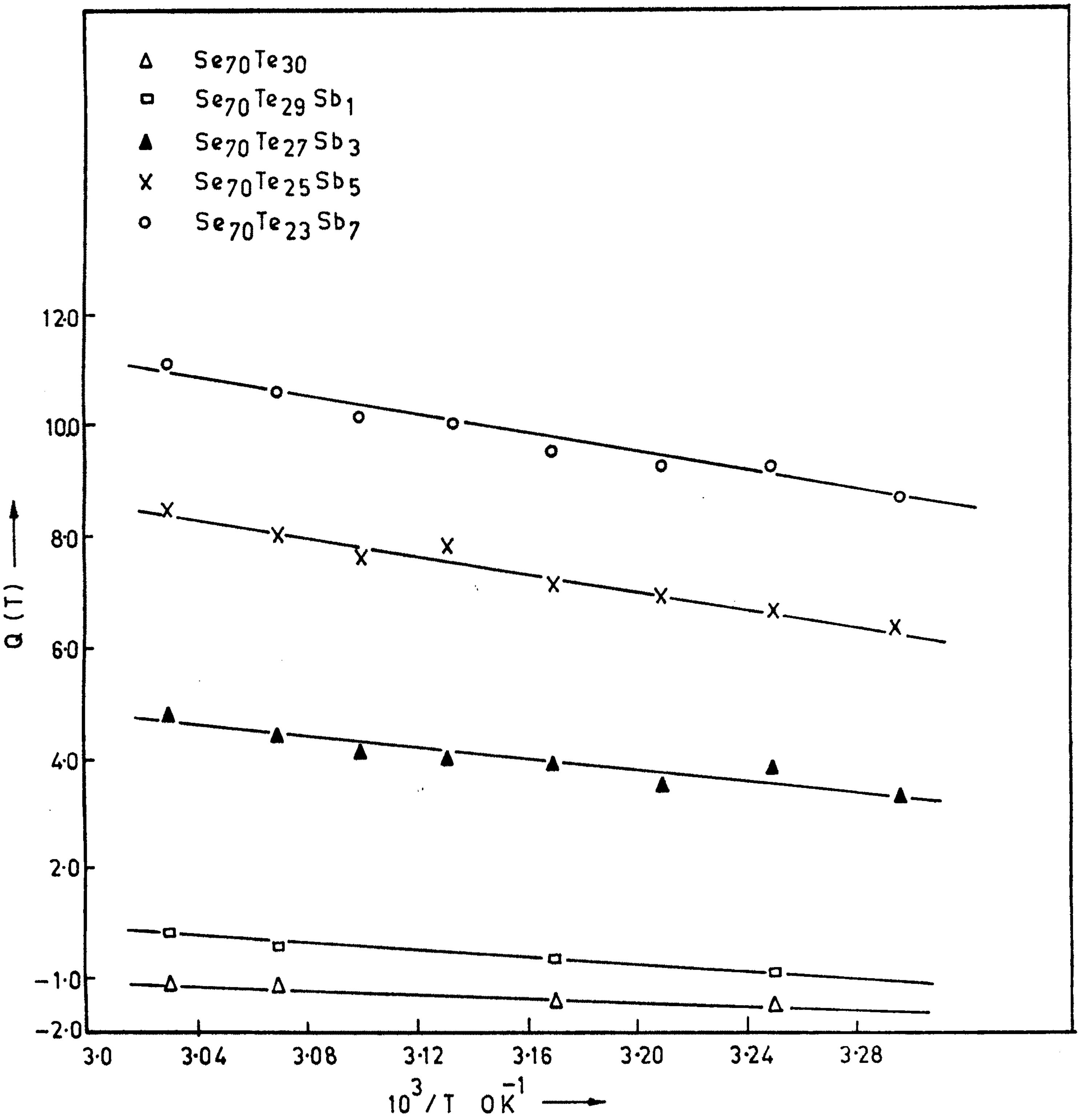
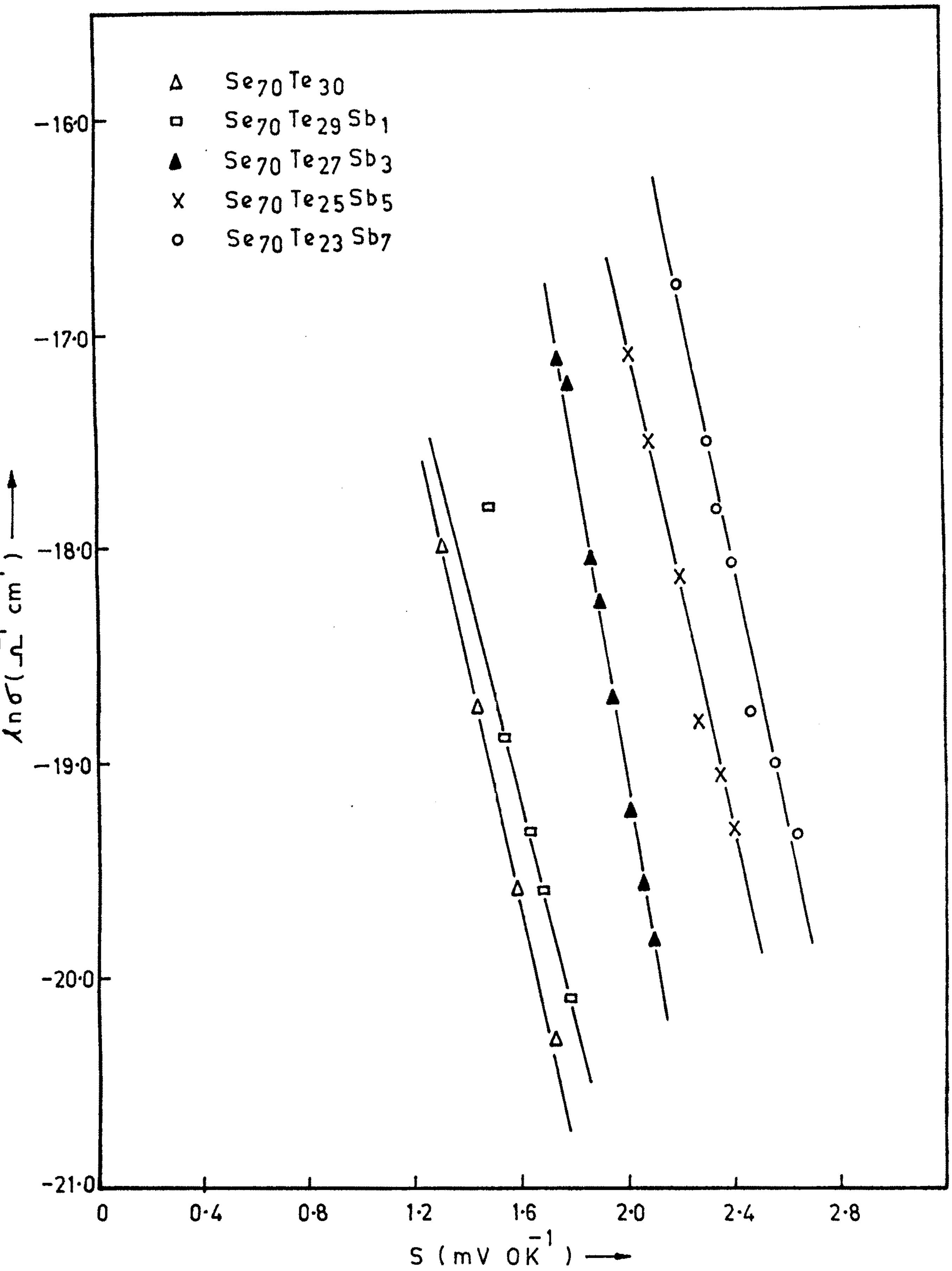


Fig. 3·22



Se70Te30
Se70Te29Sb1
Se70Te27Sb3
Se70Te25Sb5
Se70Te23Sb7
12.0
10.0
8.0
6.0
4.0
2.0
-1.0
-2.0
Q (T)
3.0
3.04
3.08
3.12
3.16
3.20
3.24
3.28
10^3/T OK^-1

Fig. 3.23



Δ Se70 Te30
□ Se70 Te29 Sb1
▲ Se70 Te27 Sb3
X Se70 Te25 Sb5
o Se70 Te23 Sb7
-16·0
-17·0
-18·0
-19·0
-20·0
-21·0
ln σ (Ω⁻¹ cm⁻¹)
0
0·4
0·8
1·2
1·6
2·0
2·4
2·8
S (mV 0K⁻¹)

Fig. 3·24

THE STUDY OF TRANSPORT PROPERTIES OF

$Sb_{70}-Se_{30-x}Cu_x$

1) I-V Characteristics
2) D.C. Conductivity
3) Field Effect on Conductivity
4) Thermo-electric Measurement.

TABLE NO. 3.19

I-V Characteristics of

(Sb - Se - Cu)

Current (μA) Voltage(V) (Volts)	$Sb_{70}Se_{25}Cu_{5}$ μA	$Sb_{70}Se_{23}Cu_{7}$ μA
0	0	0
50	0.5	0.25
100	1.0	0.75
150	1.5	1.00
200	2.0	1.50
250	2.75	2.00
300	3.50	3.00
350	4.75	4.25
400	6.00	5.25
450	7.50	6.00
500	8.75	7.00
550	10.00	8.50
600	12.50	10.00
650	14.00	12.25
700	16.00	14.00

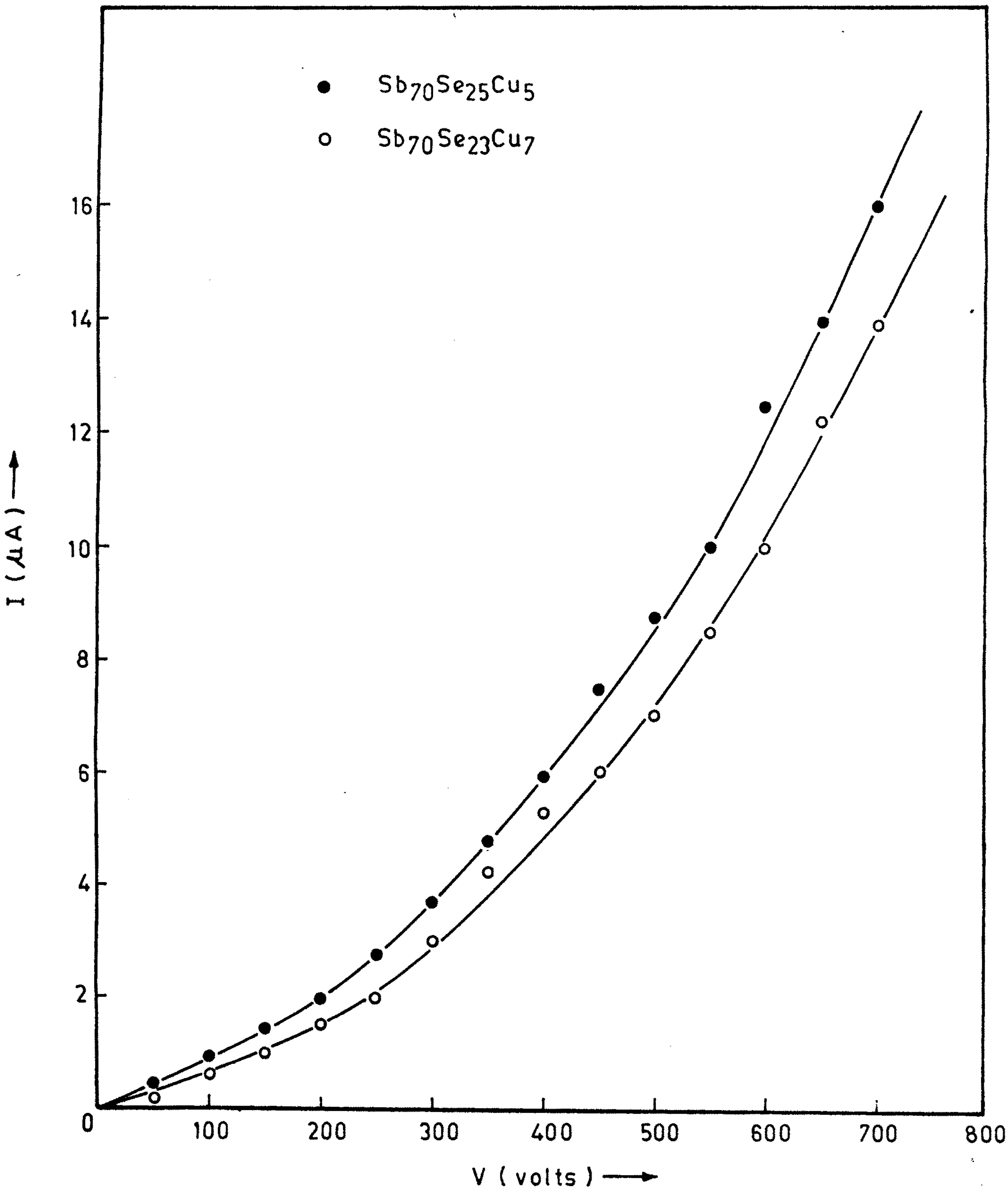

Sb70Se25Cu5
Sb70Se23Cu7
I (μA) →
V (volts) →
0
100
200
300
400
500
600
700
800
2
4
6
8
10
12
14
16

Fig. 3·25

TABLE NO. 3.20

SAMPLE $Sb_{70}Se_{25}Cu_5$

1. Voltage applied = 75 volts.
2. Thickness of pellet = 0.190 cm.
3. Area = πr^2 = 0.7855 cm^2.
4. Area/Thickness = 4.1342 cm.
5. Room Temperature = 25°C = 298°K

$10^3/T$ °K^{-1}	Current mA	R = V/I Ω	ρ = RA/x Ωcm	σ = 1/ρ Ω^{-1} cm^{-1}	logσ Ω^{-1} cm^{-1}
2.7548	0.098	0.77×10^6	3.18×10^6	3.08×10^{-7}	-6.5106
2.7932	0.082	0.91×10^6	3.76×10^6	2.58×10^{-7}	-6.5881
2.8328	0.065	1.15×10^6	4.75×10^6	2.04×10^{-7}	-6.6890
2.8735	0.052	1.44×10^6	5.95×10^6	1.63×10^{-7}	-6.7859
2.9154	0.041	1.83×10^6	7.75×10^6	1.29×10^{-7}	-6.8891
2.9585	0.030	2.42×10^6	10.01×10^6	9.45×10^{-8}	-7.0247
3.0030	0.025	3.00×10^6	12.4×10^6	7.87×10^{-8}	-7.1039
3.0487	0.016	4.69×10^6	19.39×10^6	5.04×10^{-8}	-7.2977
3.0959	0.012	6.25×10^6	25.83×10^6	3.78×10^{-8}	-7.4227
3.1446	0.008	9.38×10^6	38.78×10^6	2.52×10^{-8}	-7.5988
3.1948	0.005	15.0×10^6	62.01×10^6	1.574×10^{-8}	-7.8029
3.2467	0.003	25.0×10^6	103.4×10^6	9.44×10^{-8}	-8.0244

TABLE NO. 3.21

SAMPLE $Sb_{70}Se_{25}Cu_{7}$

1. Voltage applied = 75 volts.
2. Thickness of pellet = 0.197 cm.
3. Area $= \pi r^2$ = 0.7855 cm^2.
4. Area/Thickness = 3.9873 cm.
5. Room Temperature = 25°C = 298°K.

$10^3/T$ °K^{-1}	Current mA	R = V/I Ω	ρ = RA/x Ω cm	σ = 1/ρ $Ω^{-1}$ cm^{-1}	logσ $Ω^{-1}$ cm^{-1}
2.7548	0.88	8.52×10^4	33.97×10^4	2.87×10^{-6}	-5.5416
2.7932	0.77	9.74×10^4	38.83×10^4	2.514×10^{-6}	-5.5996
2.8328	0.65	11.53×10^4	45.97×10^4	2.122×10^{-6}	-5.6731
2.8735	0.56	13.39×10^4	53.38×10^4	1.828×10^{-6}	-5.7379
2.9154	0.44	17.05×10^4	67.98×10^4	1.436×10^{-6}	-5.8426
2.9585	0.36	20.83×10^4	83.05×10^4	1.175×10^{-6}	-5.9298
3.0030	0.25	30.0×10^4	11.96×10^5	0.8162×10^{-6}	-6.0881
3.0487	0.20	37.5×10^4	14.95×10^5	0.6530×10^{-6}	-6.1850
3.0959	0.14	53.57×10^4	21.35×10^5	0.4570×10^{-6}	-6.3339
3.1446	0.10	75.00×10^4	29.90×10^5	0.3265×10^{-6}	-6.4861
3.1948	0.07	10.71×10^5	42.70×10^5	0.2285×10^{-6}	-6.6410
3.2467	0.05	15.00×10^5	59.80×10^5	0.1672×10^{-6}	-6.7871

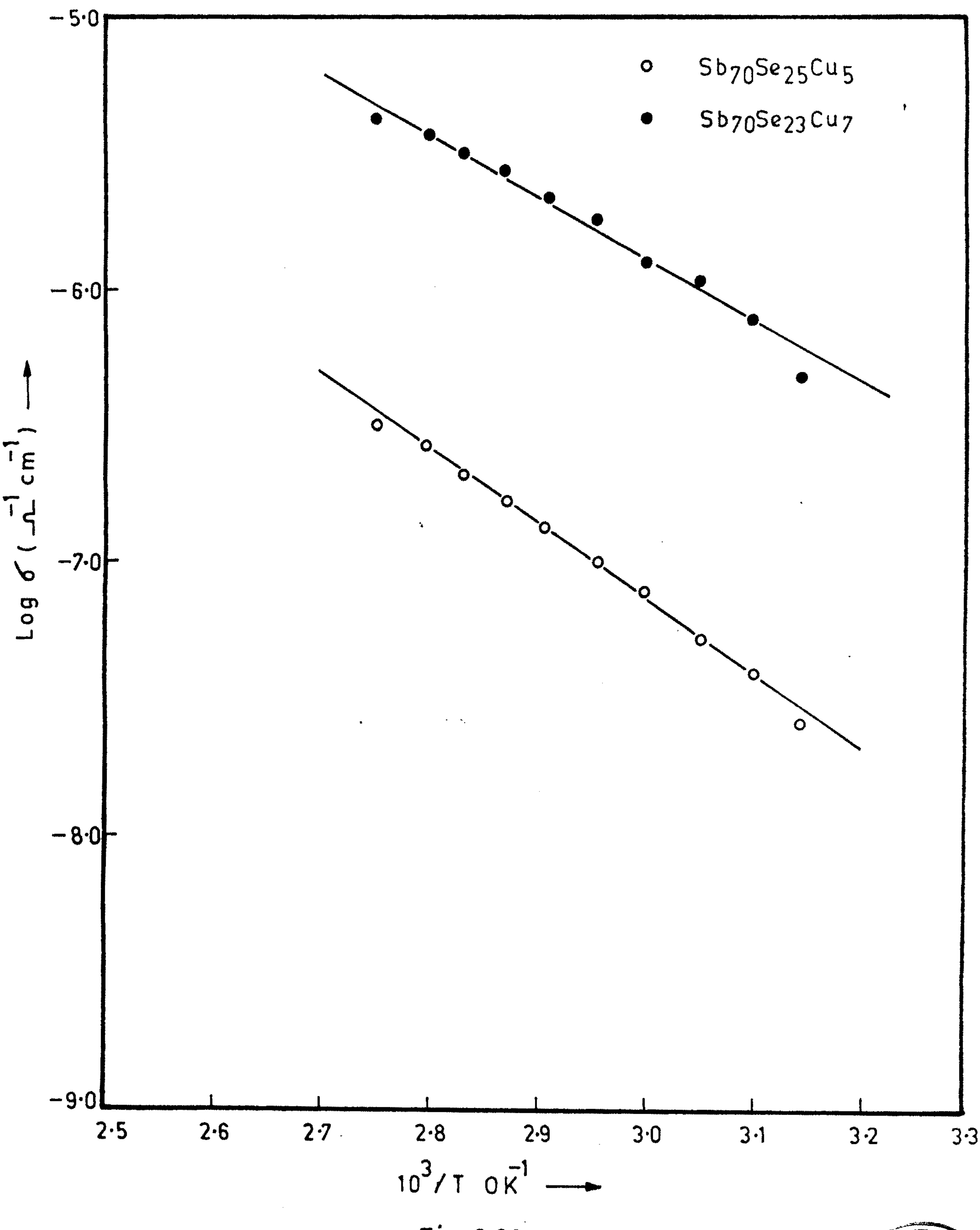


Fig. 3·26

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TABLE NO. 3.22

Variation of Conductivity with Field.

SAMPLE: $Sb_{70}Se_{25}C_5$ Thickness: 0.190 cm.

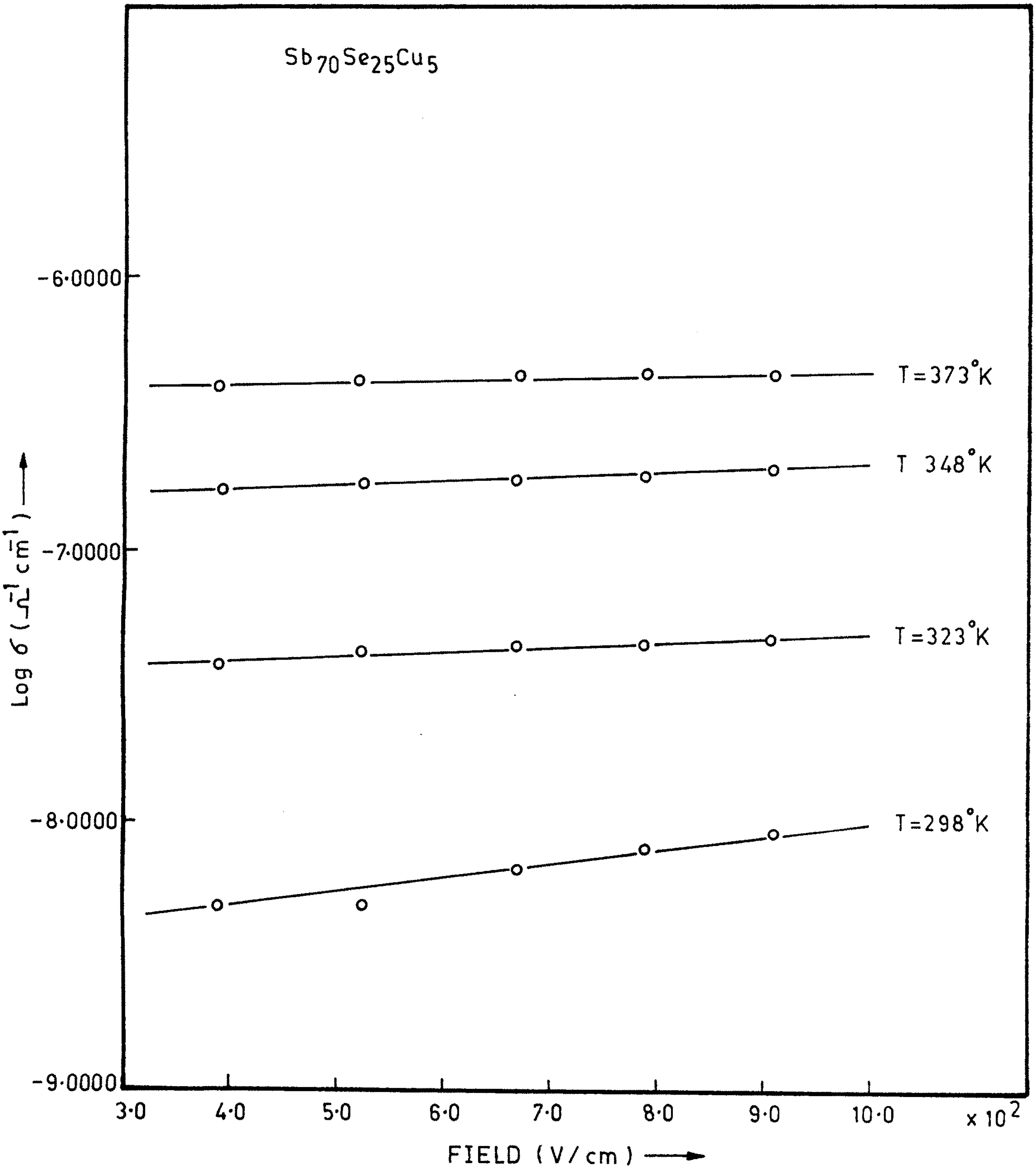
Applied Voltage (V in Volts)	Field V/cm.	25°C current mA	25°C log σ $\Omega^{-1}cm^{-1}$	50° C current mA	50° C log σ $\Omega^{-1}cm^{-1}$	75°C current mA	75°C log σ $\Omega^{-1}cm^{-1}$	100°C current mA	100°C log σ $\Omega^{-1}cm^{-1}$
75	3.95×10^2	0.0015	-8.3258	0.012	-7.4227	0.052	-6.7859	0.125	-6.4050
100	5.26×10^2	0.002	-8.3258	0.018	-7.3715	0.074	-6.7576	0.174	-6.3863
125	6.58×10^2	0.0035	-8.1796	0.023	-7.3620	0.098	-6.7325	0.227	-6.3677
150	7.89×10^2	0.005	-8.1039	0.029	-7.3405	0.124	-6.7095	0.280	-6.3557
175	9.21×10^2	0.006	-8.0917	0.035	-7.3258	0.151	-6.6909	0.343	-6.3346

TABLE NO. 3.23

Variation of conductivity with field.

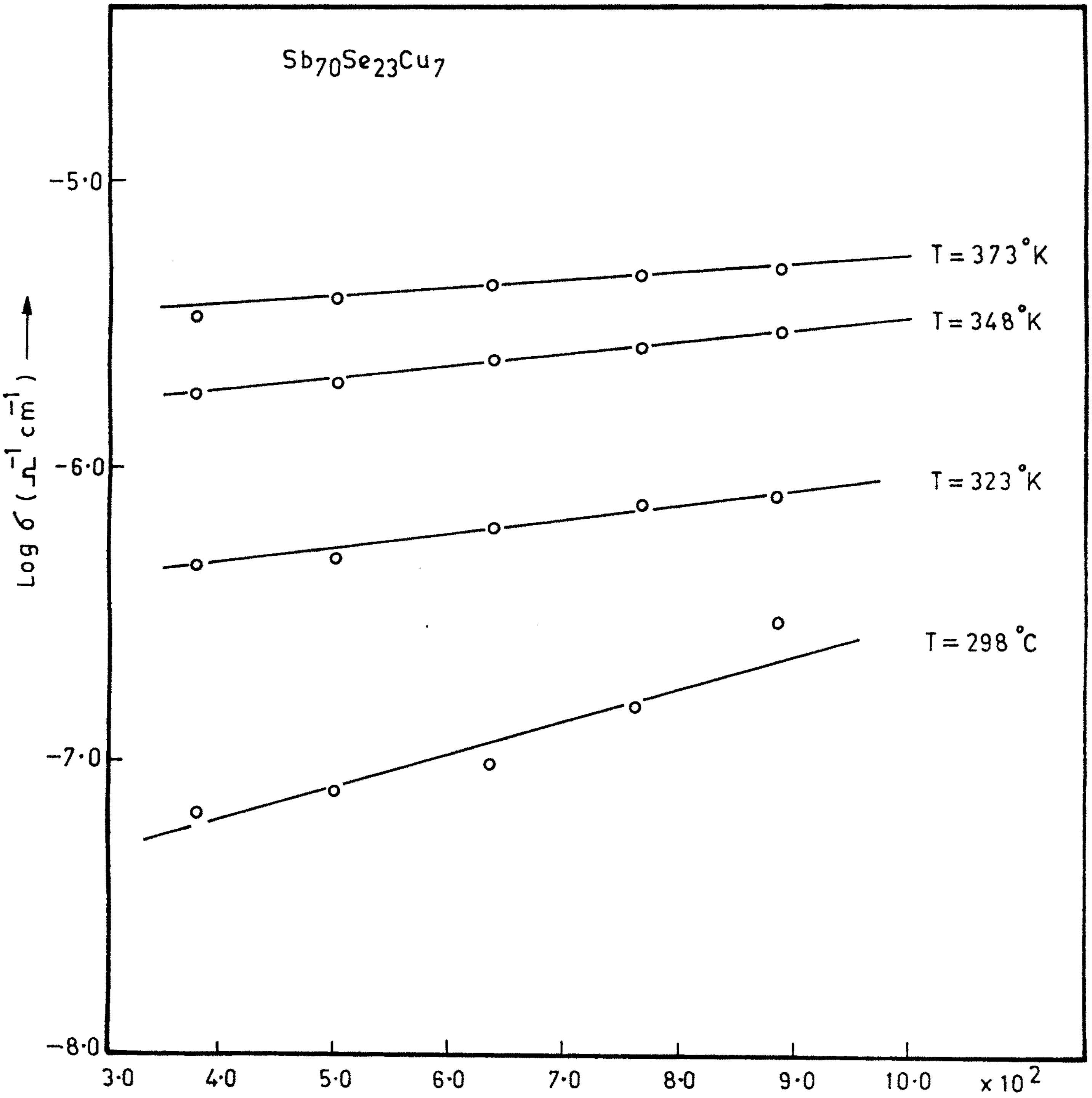
SAMPLE : $Sb_{70}Se_{23}Cu_7$ Thickness : 0.197 cm.

Applied	Field	25°C		50°C		75°C		100°C	
Voltage (V in Volts)	V/cm.	Current mA	logσ $\Omega^{-1}cm^{-1}$	Current mA	logσ $\Omega^{-1}cm^{-1}$	Current mA	logσ $\Omega^{-1}cm^{-1}$	Current mA	logσ $\Omega^{-1}cm^{-1}$
75	3.81×10^2	0.02	-7.1850	0.14	-6.3339	0.56	-5.7379	1.03	-5.4772
100	5.08×10^2	0.04	-7.1530	0.22	-6.3019	0.87	-5.6915	1.55	-5.4027
125	6.35×10^2	0.06	-7.0019	0.33	-6.2114	1.24	-5.6123	2.15	-5.3615
150	7.61×10^2	0.10	-6.7871	0.45	-6.1339	1.65	-5.5696	2.92	-5.3217
175	8.88×10^2	0.15	-6.5225	0.61	-6.0950	2.27	-5.5013	3.9	-5.3019



$Sb_{70}Se_{25}Cu_5$
T=373°K
T 348°K
T=323°K
T=298°K
-6·0000
-7·0000
-8·0000
-9·0000
3·0
4·0
5·0
6·0
7·0
8·0
9·0
10·0
x 10²
FIELD (V/cm) →
Log σ (Ω⁻¹ cm⁻¹) →

Fig. 3·27



Sb70Se23Cu7
-5·0
-6·0
-7·0
-8·0
Log σ (Ω⁻¹ cm⁻¹) →
T = 373 °K
T = 348 °K
T = 323 °K
T = 298 °C
3·0
4·0
5·0
6·0
7·0
8·0
9·0
10·0
x 10²
FIELD (V/cm) →

Fig. 3·28

TABLE NO. 3.24

Thermoelectric Measurement of

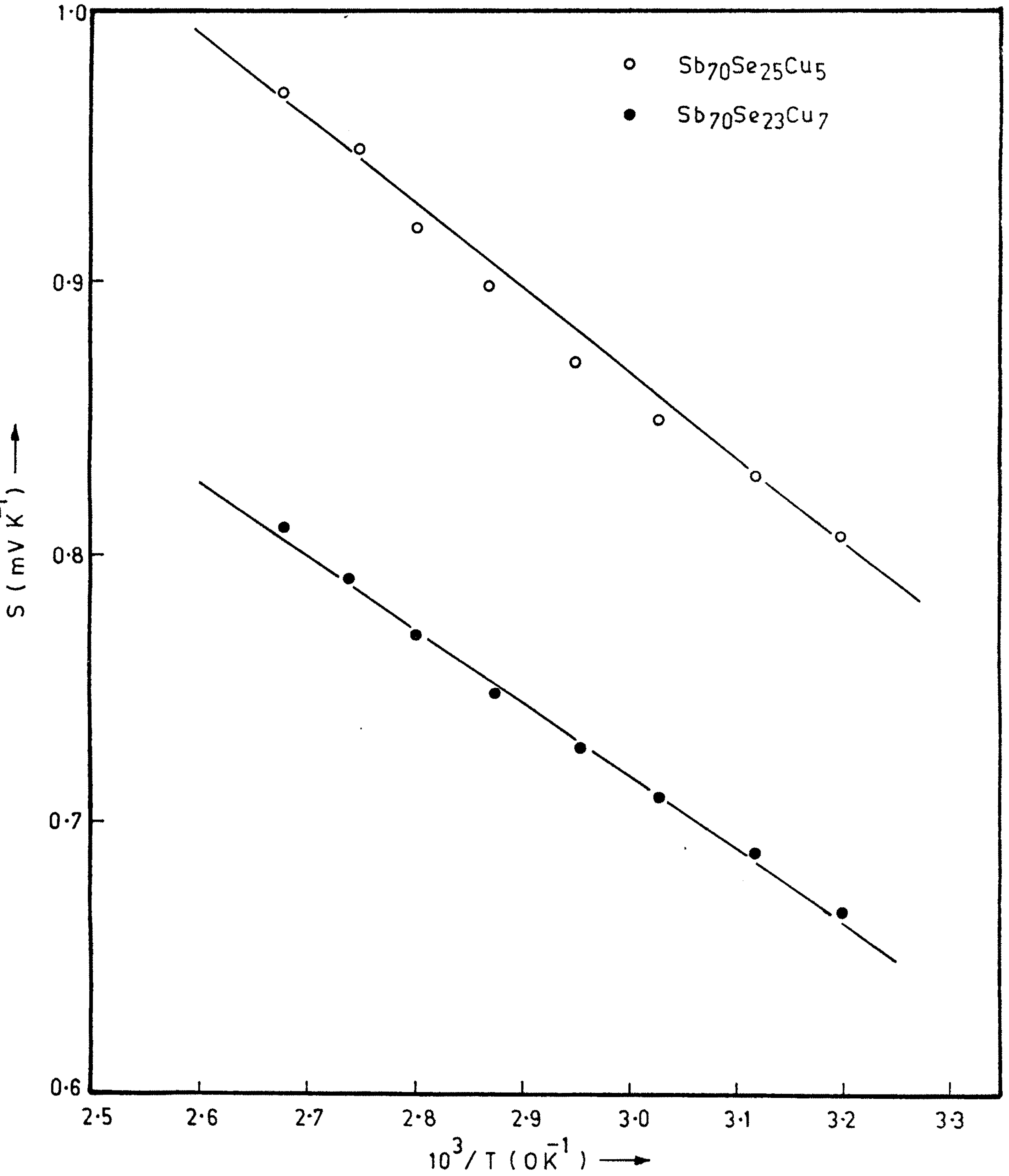
$Sb_{70}Se_{25}Cu_5$

Temp. of One end T_1 °C	Temp. of Other end T_2 °C	ΔT (°C)	ΔV (mV)	$T = T_1 - \frac{\Delta T}{2}$	$10^3/T$ °K^{-1}	$S = \frac{\Delta V}{\Delta T}$ (mV K^{-1})
40	37.5	2.5	2.43	311.75	3.208	0.9726
50	43.0	5.0	4.73	320.50	3.120	0.9459
60	52.5	7.5	6.90	329.25	3.037	0.9208
70	60.0	10.0	8.96	338.00	2.958	0.8968
80	67.5	12.5	10.93	346.75	2.883	0.8741
90	75.0	15.0	12.79	355.50	2.812	0.8525
100	82.5	17.5	14.56	340.25	2.745	0.8322
110	90.0	20.0	16.25	373.00	2.681	0.8128

TABLE NO. 3.25

Thermoelectric Measurement of $Se_{70}Se_{23}Cu_7$

Temp. of One end T_1°C	Temp. of Other end T_2°C	ΔT (°C)	ΔV (mV)	$T = T_1 - \frac{\Delta T}{2}$	$10^3/T$ °K^{-1}	$S = \frac{\Delta V}{\Delta T}$ (mV K^{-1})
40	37.5	2.5	2.03	311.75	3.208	0.8106
50	45.0	5.0	3.94	320.50	3.120	0.7884
60	52.5	7.5	5.75	329.25	3.037	0.7674
70	60.0	10.0	7.47	338.00	2.958	0.7470
80	67.5	12.5	9.10	346.75	2.883	0.7285
90	75.0	15.0	10.65	355.5	2.812	0.7105
100	82.5	17.5	12.14	364.25	2.745	0.6936
110	90.0	20.0	13.55	373.00	2.681	0.6774



Sb70Se25Cu5
Sb70Se23Cu7
1·0
0·9
0·8
0·7
0·6
S (mV K⁻¹) →
2·5
2·6
2·7
2·8
2·9
3·0
3·1
3·2
3·3
10³/ T (OK⁻¹) →

Fig. 3·29

Table No. 3.26

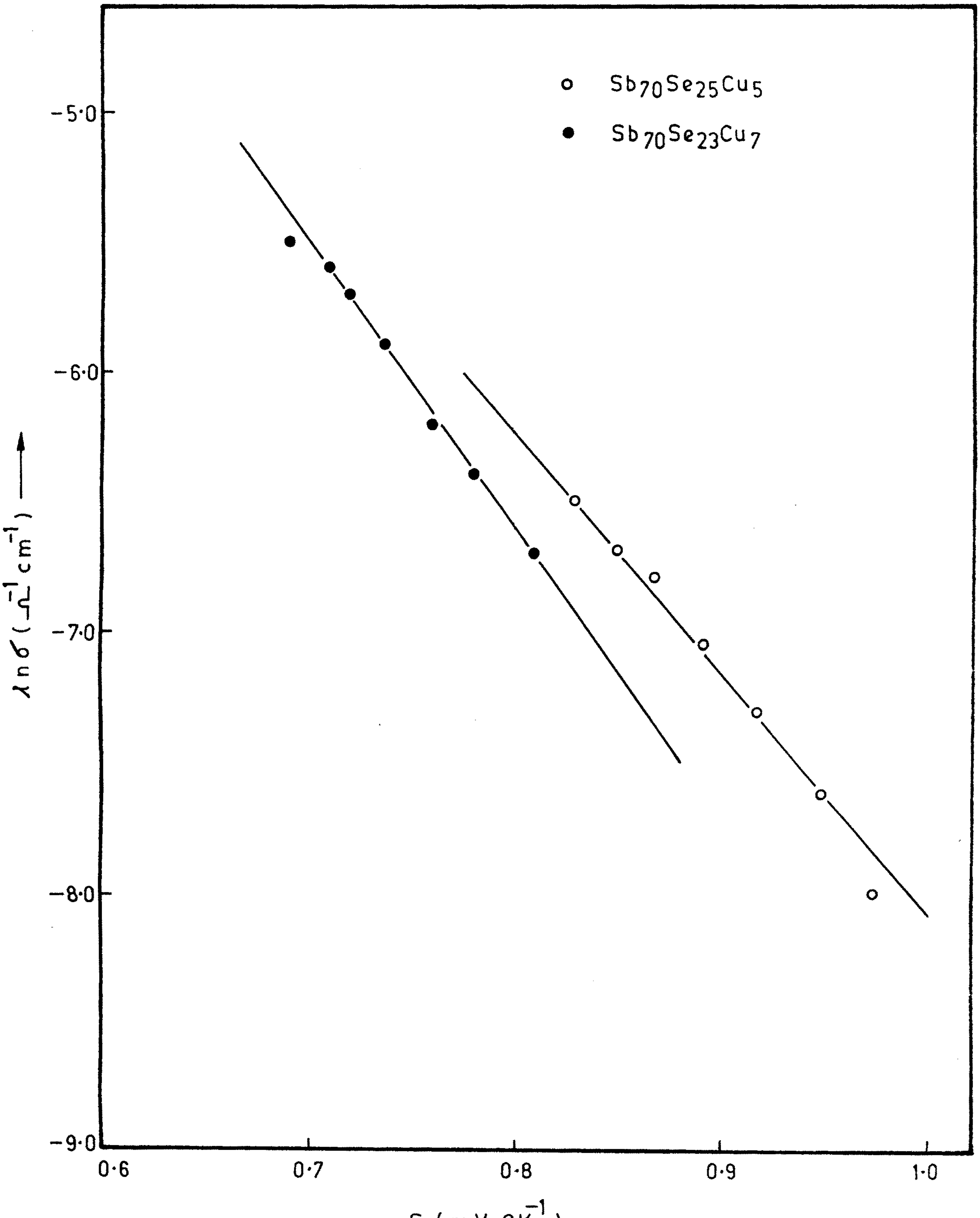
$Sb_{70}Se_{25}Cu_5$

$\frac{10^3}{T}$/°K	ln σ(T) $\Omega^{-1}cm^{-1}$	S(T) mV/°K	Q_T = lnσ(T)+11.608 x S(T)
3.208	-8.0244	0.9726	3.2655
3.120	-7.5988	0.9459	3.3812
3.037	-7.2977	0.9208	3.3909
2.958	-7.0247	0.8968	3.3853
2.883	-6.7859	0.8741	3.3606
2.812	-6.6890	0.8525	3.2068
2.745	-6.5106	0.8322	2.9711

Table No: 3.27

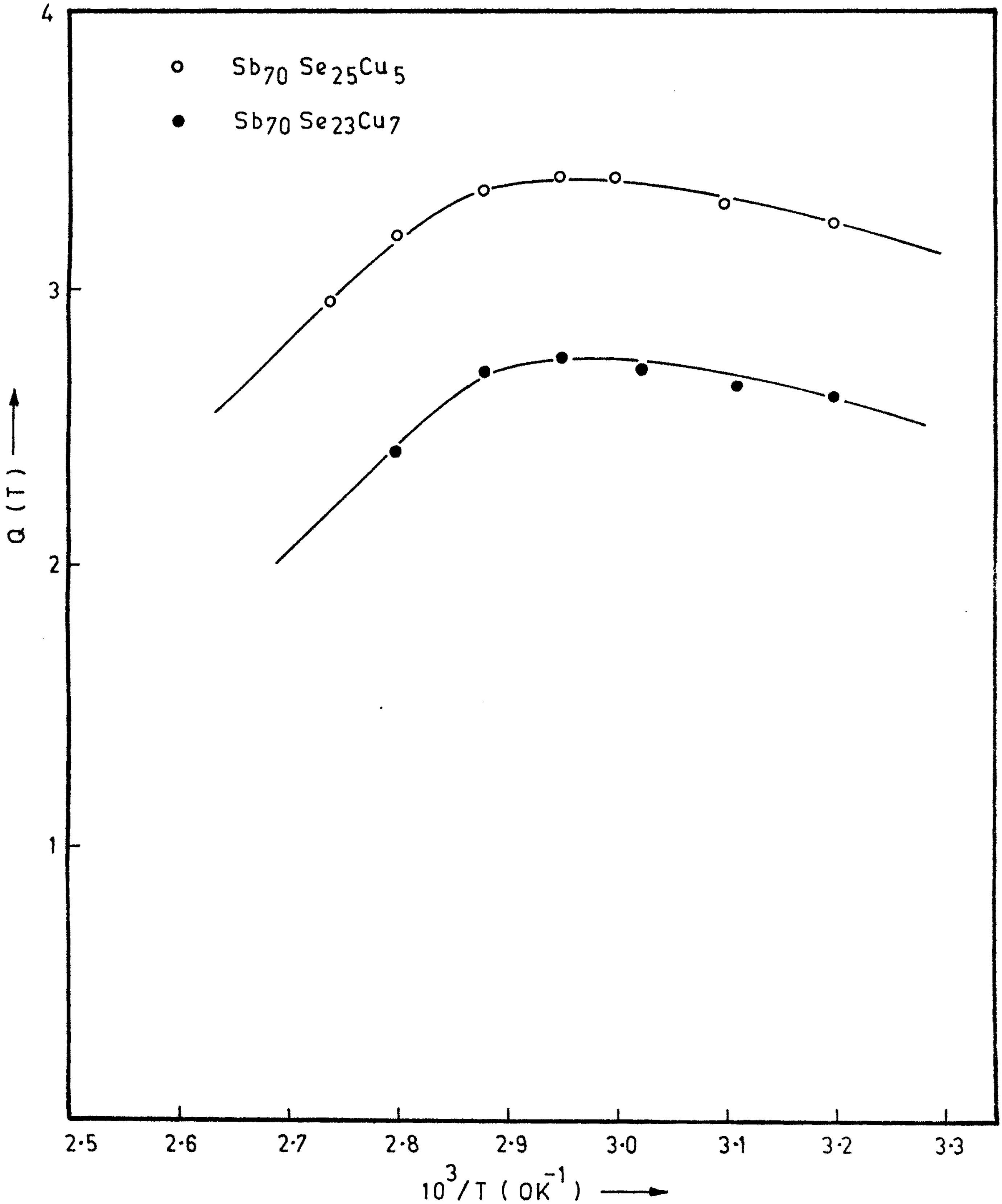
$Sb_{70}Se_{23}Cu_{7}$

$\frac{10^3}{T}$/°K	Lnσ(T) $\Omega^{-1}cm^{-1}$	S(T) mV/°K	QT= lnσ(T)+11.608 + S(T)
3.208	-6.7871	0.8106	2.6223
3.120	-6.4861	0.7884	2.6656
3.037	-6.1850	0.7674	2.7229
2.958	-5.9298	0.7470	2.7413
2.883	-5.7379	0.7285	2.7185
2.812	-5.6731	0.6936	2.5743
2.745	-5.5996	0.6774	2.4517



Sb70Se25Cu5
Sb70Se23Cu7
-5·0
-6·0
-7·0
-8·0
-9·0
ln σ (Ω⁻¹ cm⁻¹) →
0·6
0·7
0·8
0·9
1·0
S (mV OK⁻¹) →

Fig. 3·30



4
3
2
1
Sb70 Se25Cu5
Sb70 Se23Cu7
Q (T)
2·5
2·6
2·7
2·8
2·9
3·0
3·1
3·2
3·3
10^3/T (OK^-1)

Fig. 3·31

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