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IMPROVED SILICON-GERMANIUM
THERMOELECTRIC MATERIAL DEVELOPMENT
PROGRAM SUMMARY REPORT

Prepared for:

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Waltham, Massachusetts

July 1988

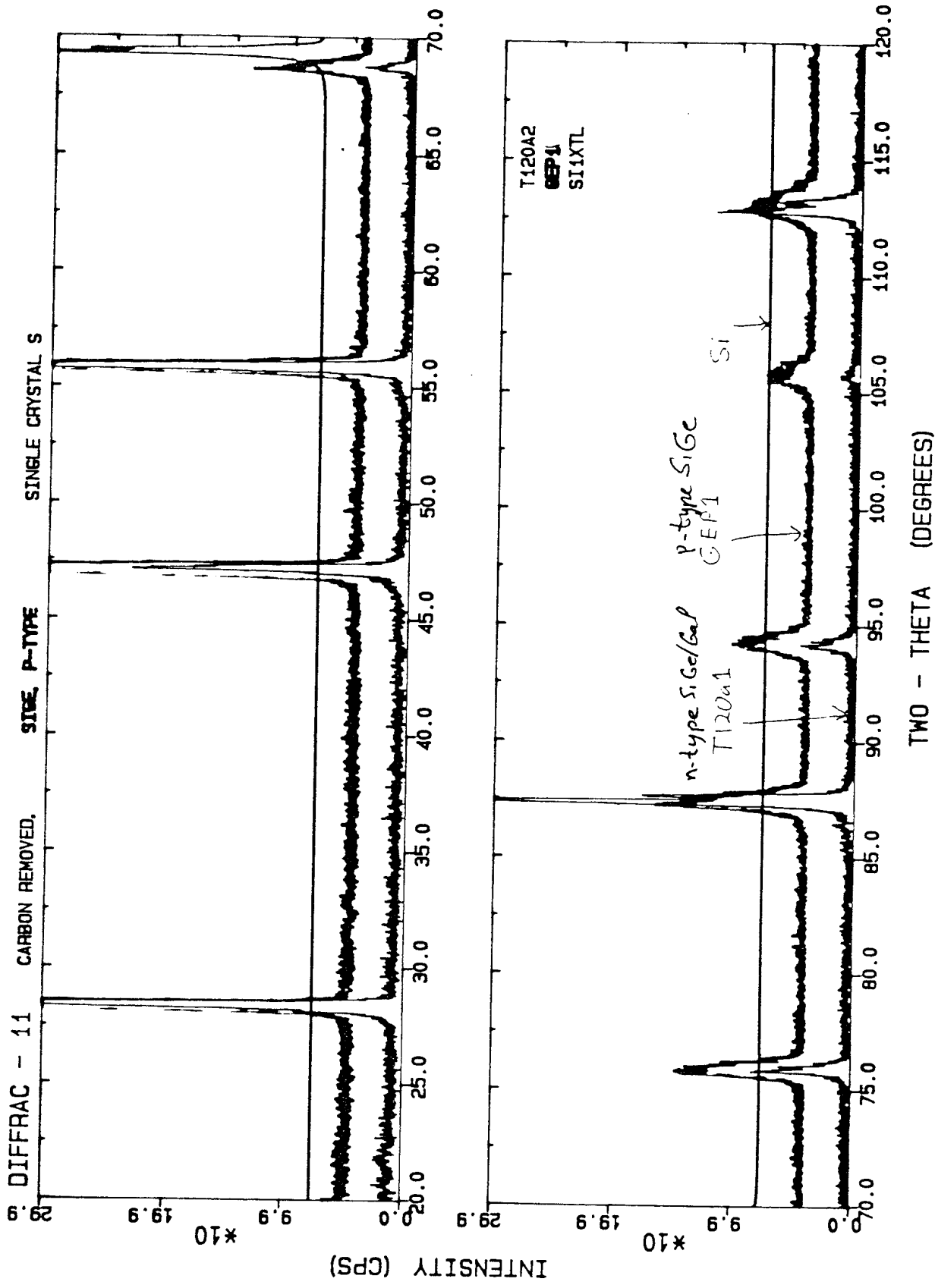


FIGURE 4: X-RAY DIFFRACTION DATA FOR T120a1 (BOTTOM), CEP-1 (MIDDLE) AND SINGLE CRYSTAL Si (TOP).

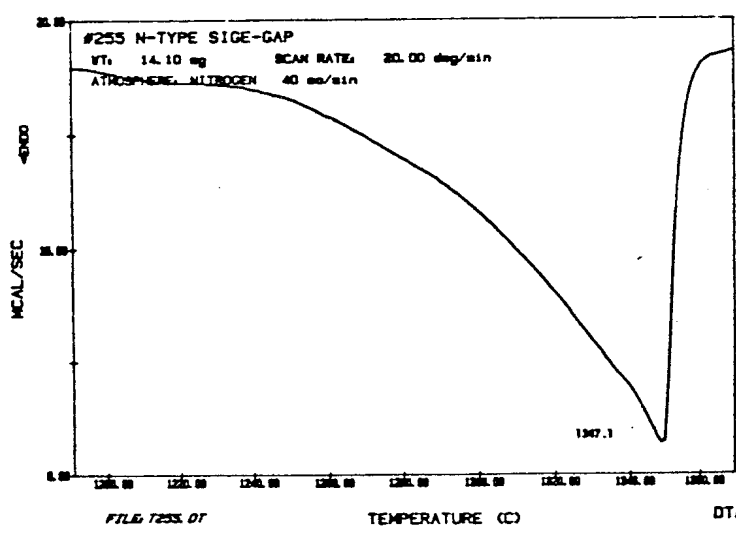
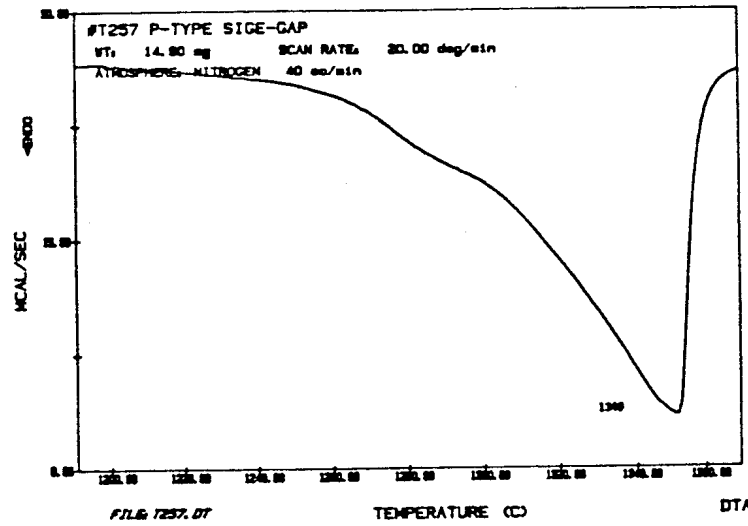
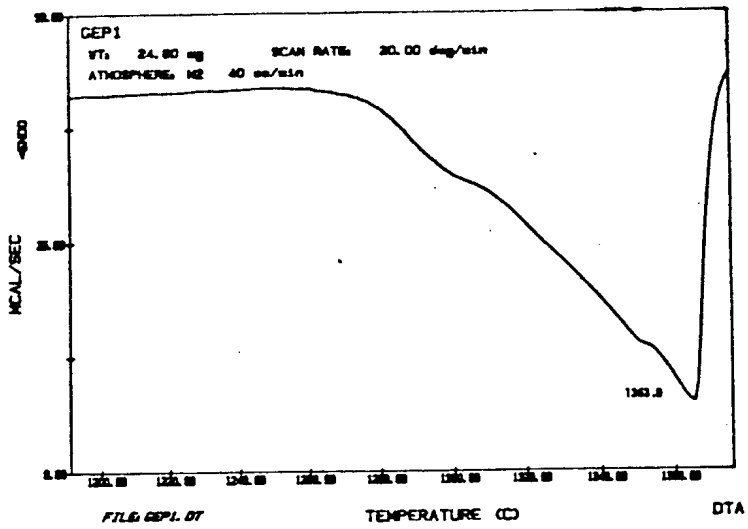


Figure 5: Differential thermal analysis as a function of temperature for p-type SiGe and p- and n-type SiGe/GaP

THERMAL EXPANSION
GEP-1-T

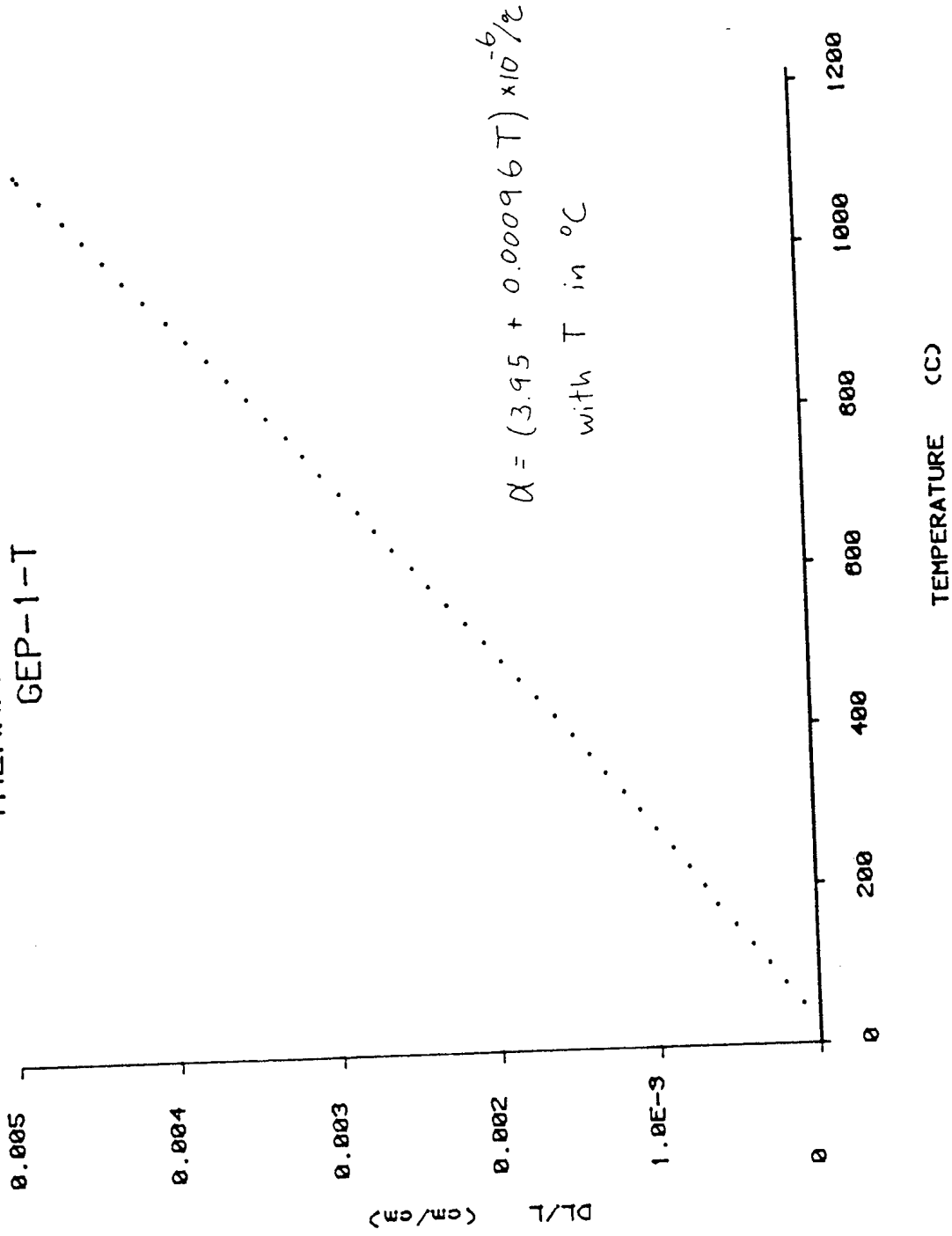


Figure 6: Thermal expansion as a function of temperature of GE p-type SiGe. The curvature indicates a temperature dependent thermal expansion coefficient.

THERMAL EXPANSION
SiGe-GaP N-TYPE #T255

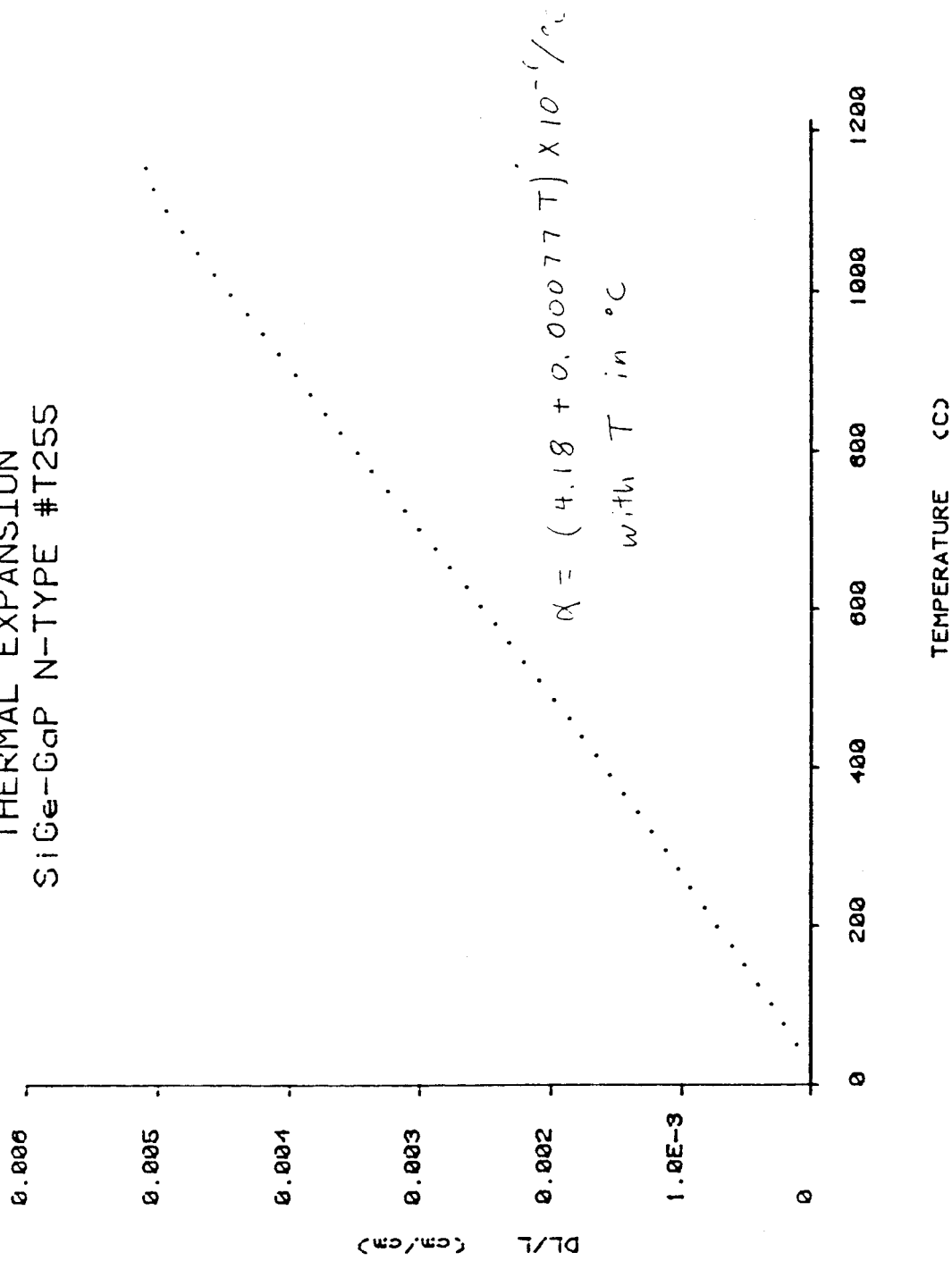


Figure 7: Thermal expansion as a function of temperature of TECO n-type SiGe/GaP. The curvature indicates a temperature dependent thermal expansion coefficient.

THERMAL EXPANSION
 SiGe-GaP P-TYPE #T257

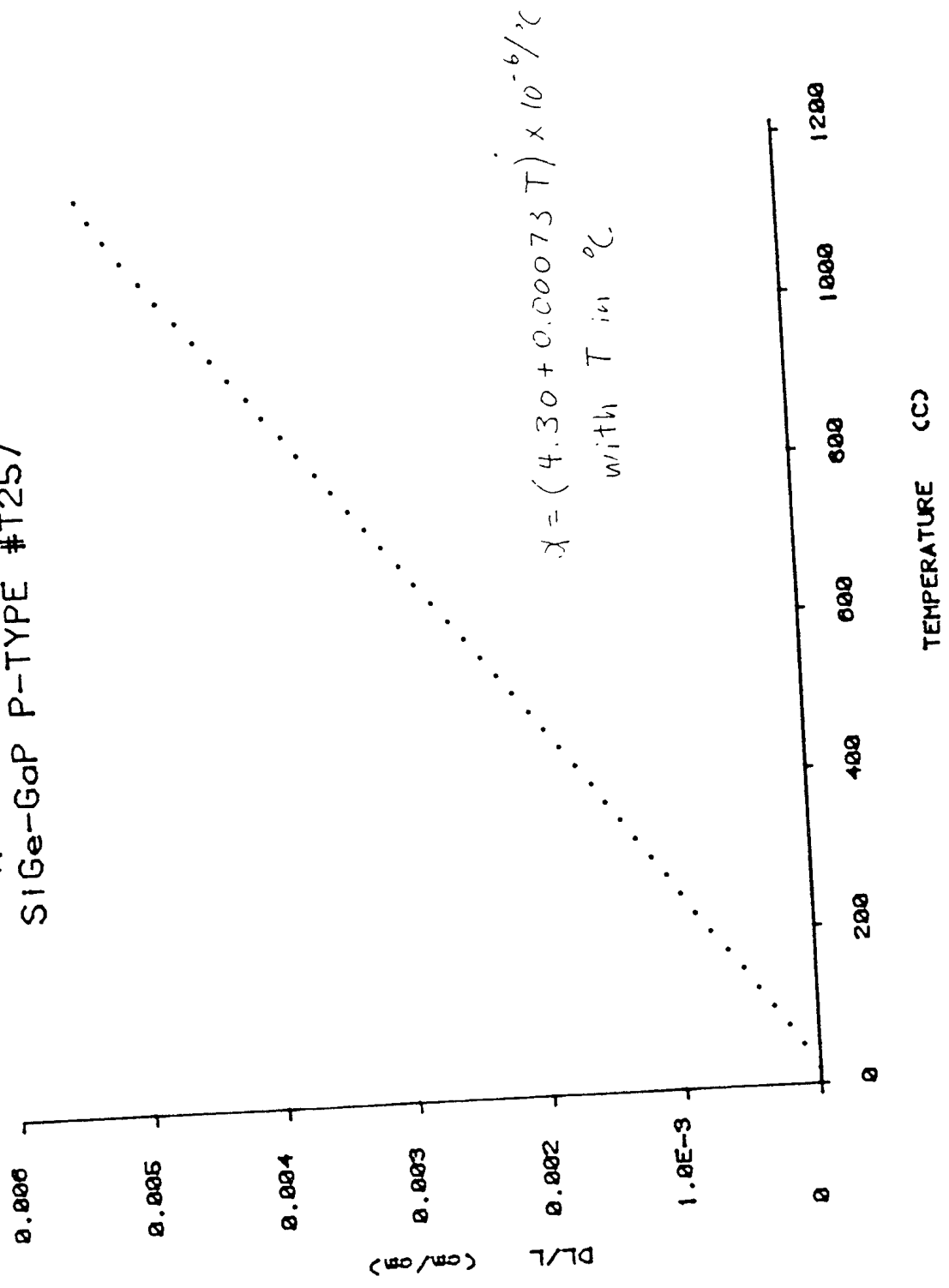


Figure 8: Thermal expansion as a function of temperature of TECO p-type SiGe/GaP. The curvature indicates a temperature dependent thermal expansion coefficient.

TABLE 5: TENSILE STRENGTH OF SEVERAL SILICON GERMANIUM BASED SAMPLES
 DATA BASED UPON AVERAGE OF THREE SAMPLES
 STANDARD DEVIATIONS ARE SHOWN IN PARENTHESIS
 (4 Point flexure test, spans = 1.25" and 0.625")

SAMPLE	TEMPERATURE C	MAXIMUM . STRESS (kpsi)	MAXIMUM STRAIN (%)	MODULUS (Mpsi)
GEP-1, GE p-type SiGe	25	29.2(1.5)	0.147(0.008)	19.8(0.06)
	500	42.4(2.1)	0.20(0.02)	21.9(1.5)
	1100	45.0(10.0)	0.49	15.0(0.06)
T-257, TECO p-type SiGe/GaP	25	10.8(3.0)	0.06(0.02)	17.9(0.4)
	500	15.9(4.1)	0.06(0.01)	26.2(2.5)
	1100	51.3(30.1)	0.55(0.47)	15.5(0.9)
T-255, TECO n-type SiGe/GaP	25	18.7(1.0)	0.112(0.008)	21.0(2.6)
	500	20.8(3.2)	0.10(0.02)	23.9(0.9)
	1100	26.4*	>0.69	16.6(2.5)

* = two samples did not fail. Highly ductile at this temperature.

TABLE 6: COMPRESSIVE STRENGTH OF SILICON GERMANIUM BASED SAMPLES
 DATA BASED UPON AVERAGE OF THREE SAMPLES
 STANDARD DEVIATIONS ARE SHOWN IN PARENTHESIS
 (0.25" diameter by 0.5" long cylinders, at 25 C)

SAMPLE	MAXIMUM STRESS (kpsi)	MAXIMUM STRAIN (%)	MODULUS (Mpsi)
GEP-1, GE p-type SiGe	94.7(14.5)	0.42(0.06)	22.4(0.33)
T-257, TECO p-type SiGe/GaP	58.4(7.0)	0.30(0.03)	19.6(0.21)
T-255, TECO n-type SiGe/GaP	68.6(6.2)	0.37(0.04)	18.7(0.5)

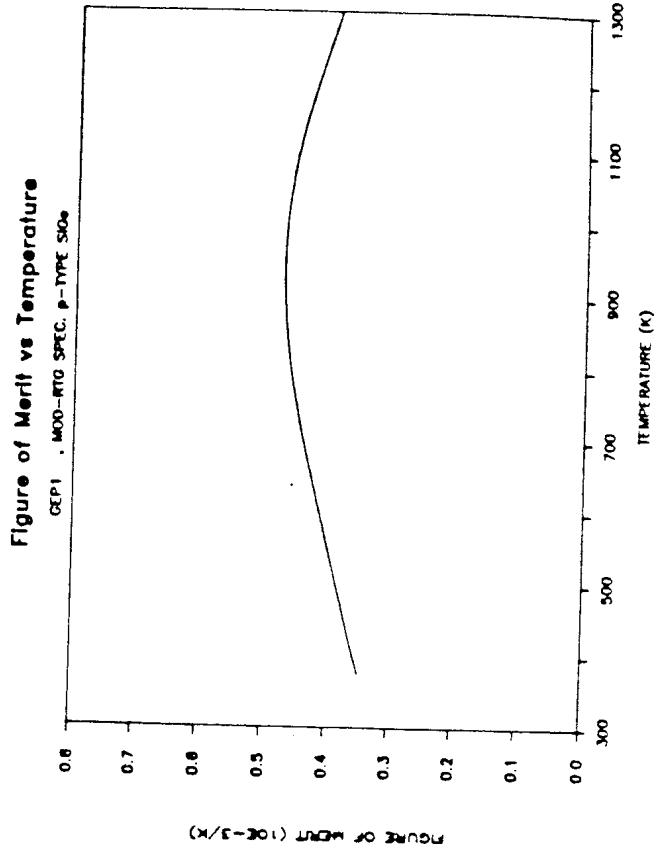
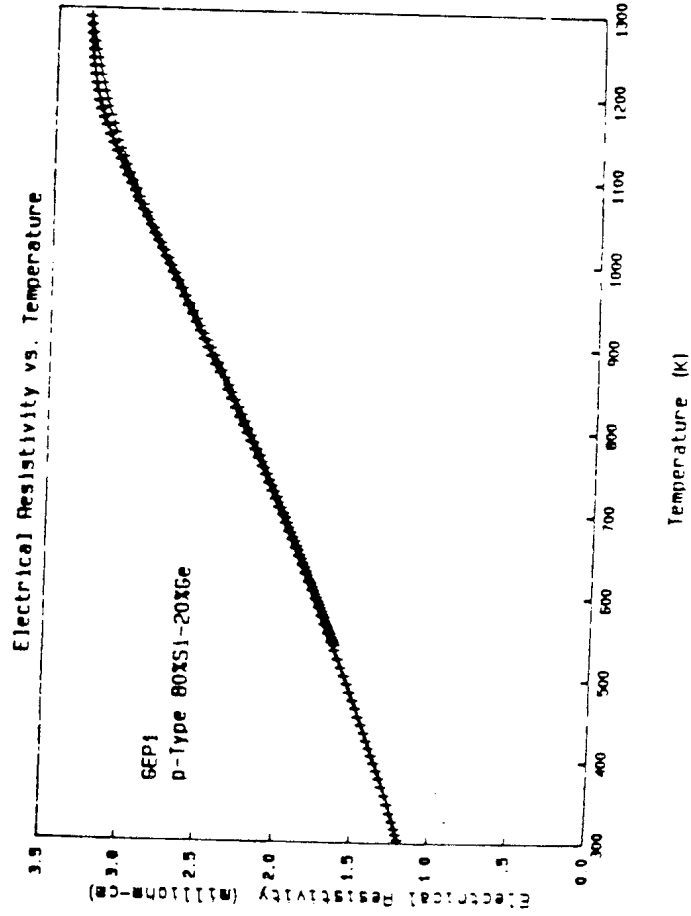
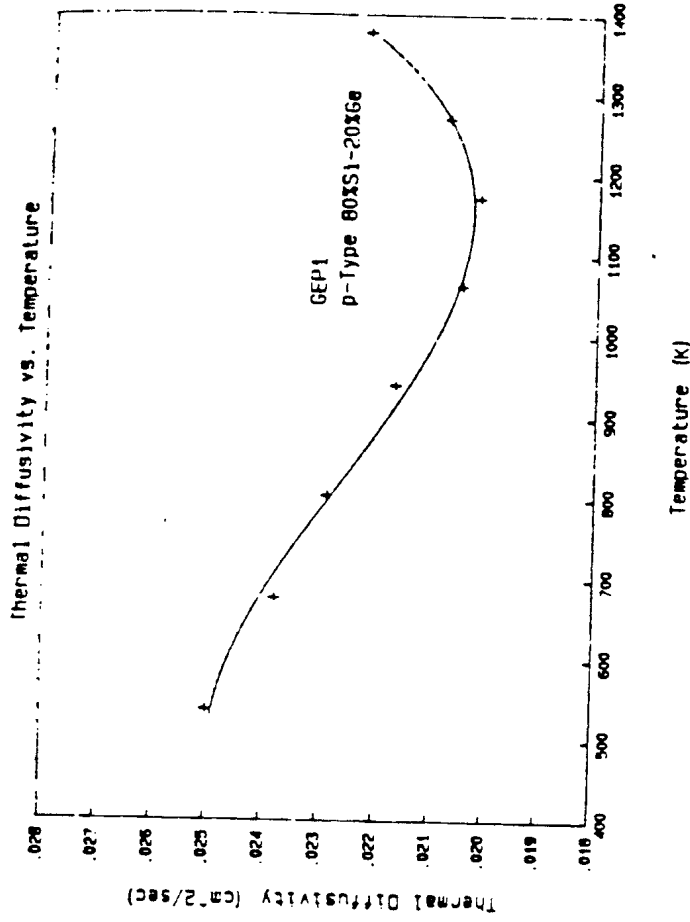
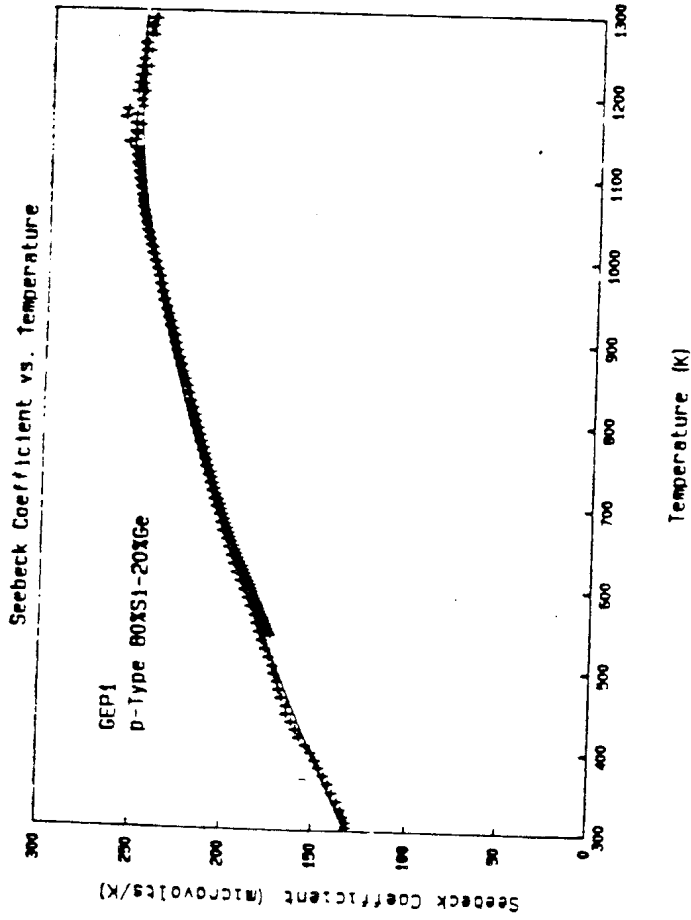


FIGURE 21 THERMOELECTRIC PROPERTIES OF GEP-1, p-TYPE SiGe, PREPARED AND CHARACTERIZED AT GE.

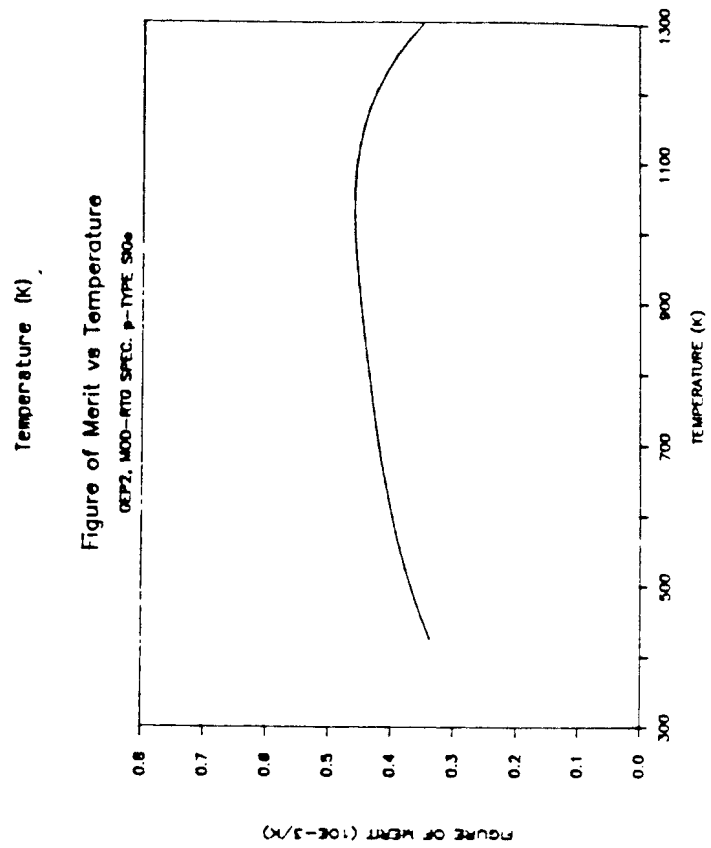
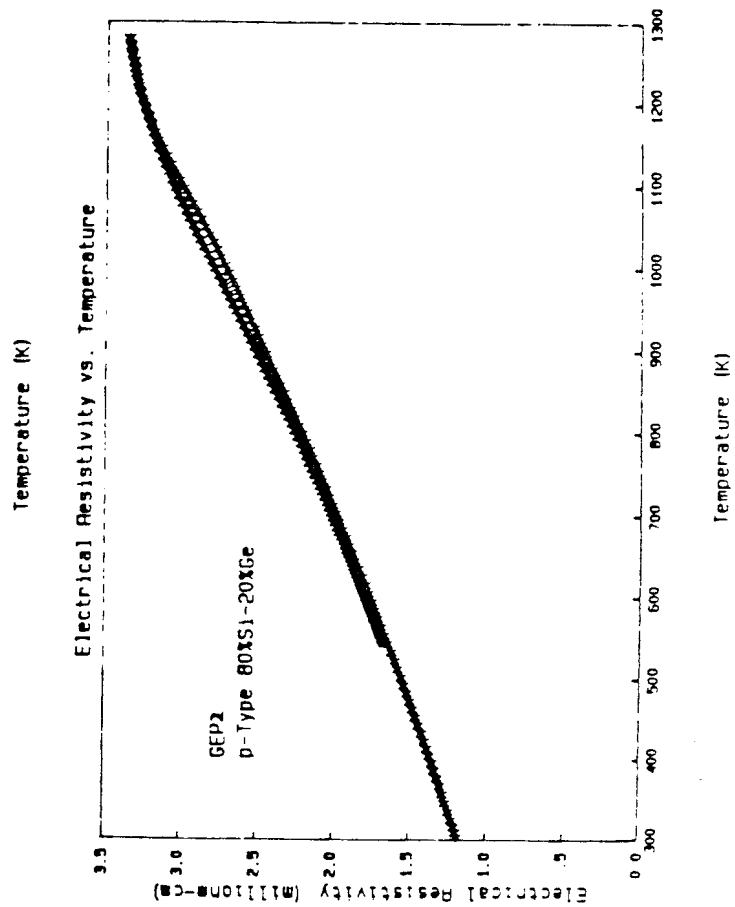
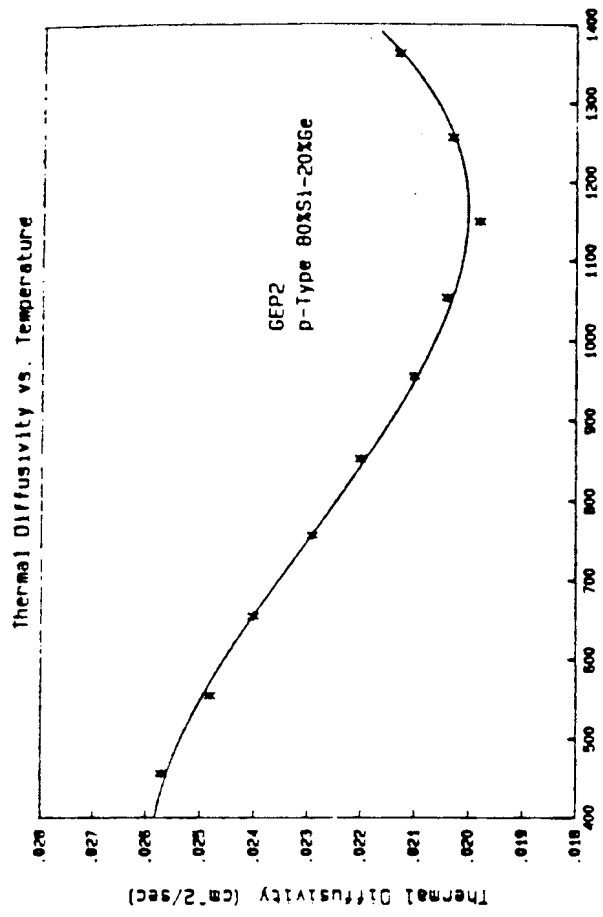
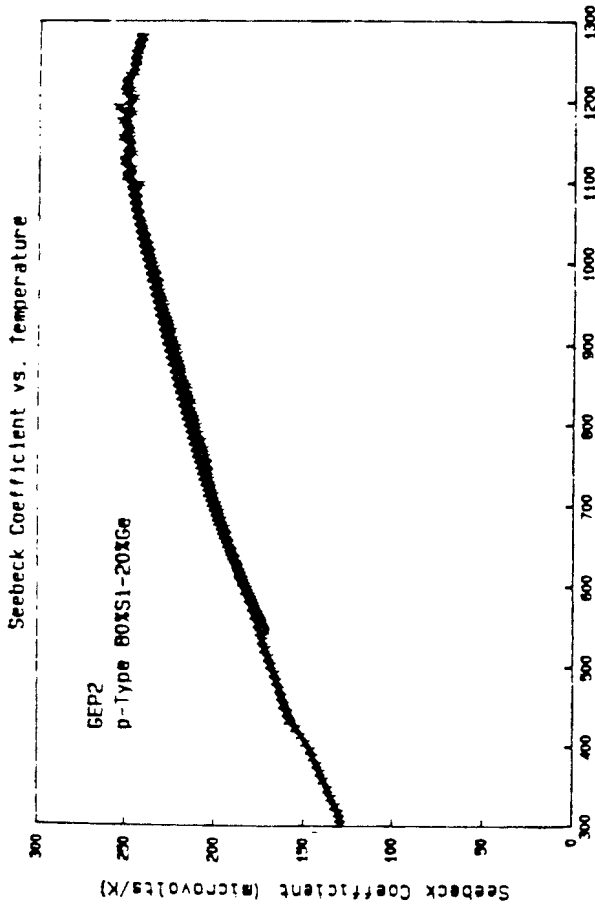


FIGURE 22. THERMOELECTRIC PROPERTIES OF GEP-2, p-TYPE SiGe, PREPARED AND CHARACTERIZED AT GE.

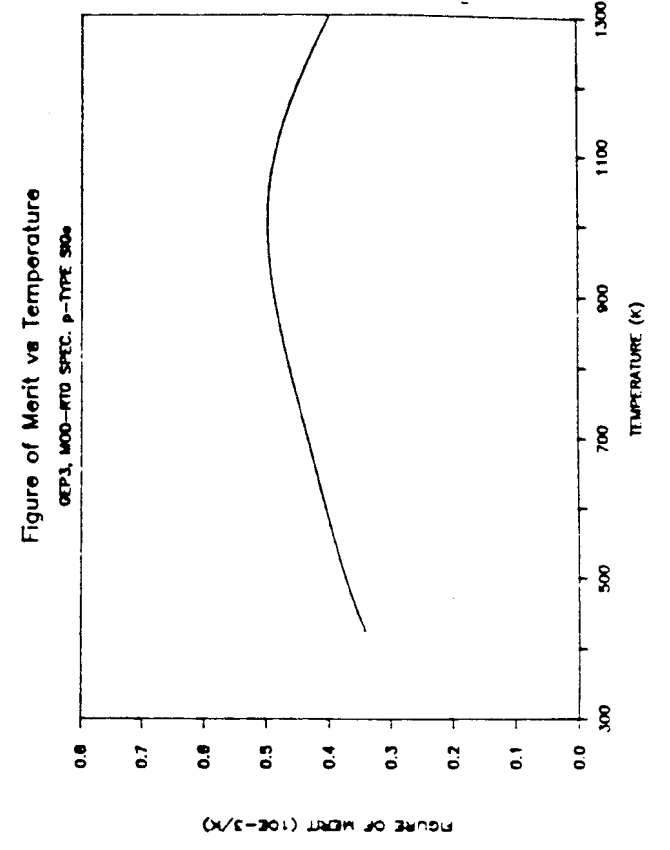
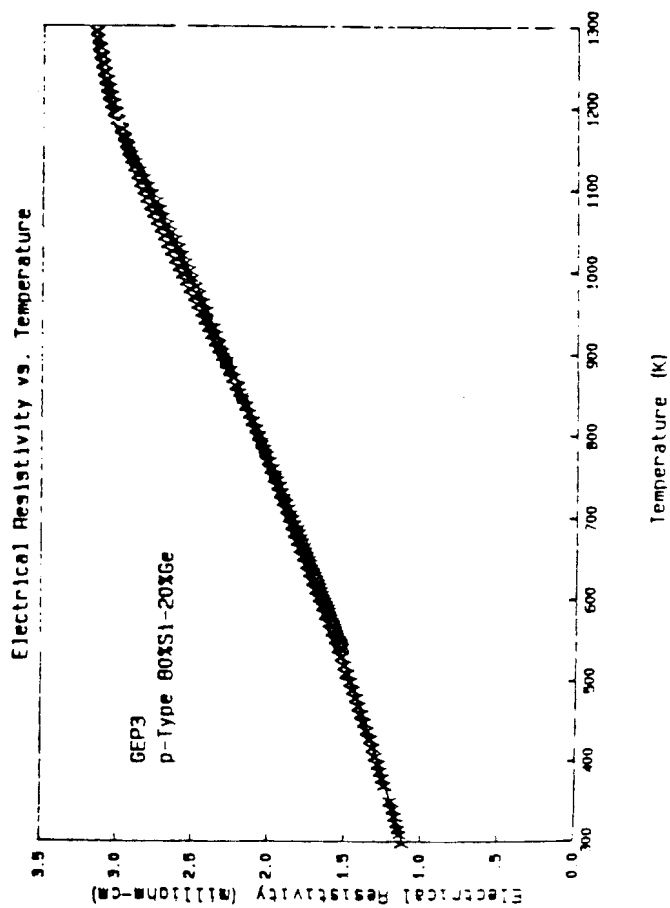
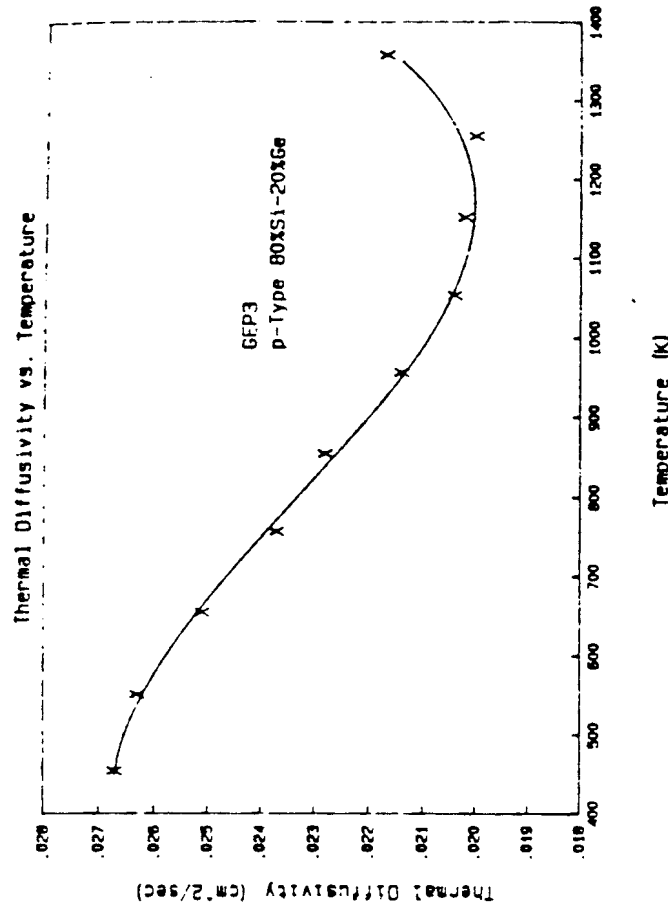
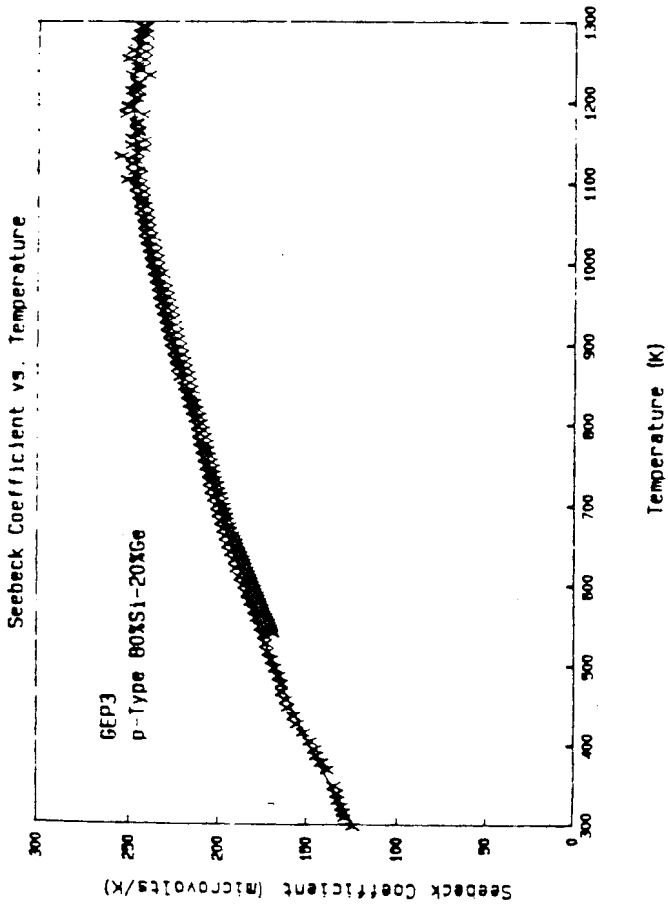


FIGURE 23 THERMOELECTRIC PROPERTIES OF GEP-3, p-TYPE SiGe, PREPARED AND CHARACTERIZED AT GE.

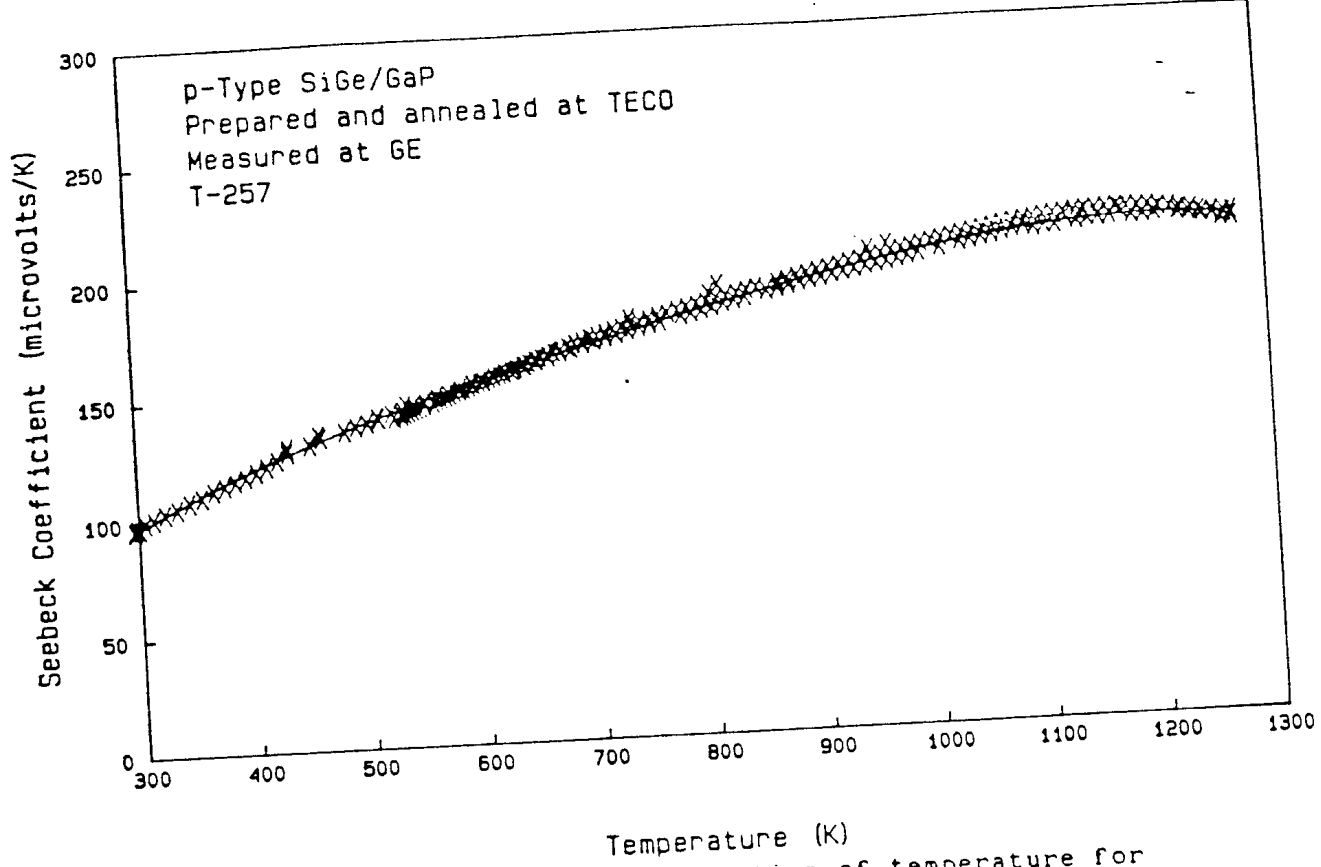


Figure 24 Seebeck coefficient as a function of temperature for T-257, p-type SiGe/GaP. Both warming and cooling data are shown. The solid line represents a fit to the warming data used for figure of merit calculations.

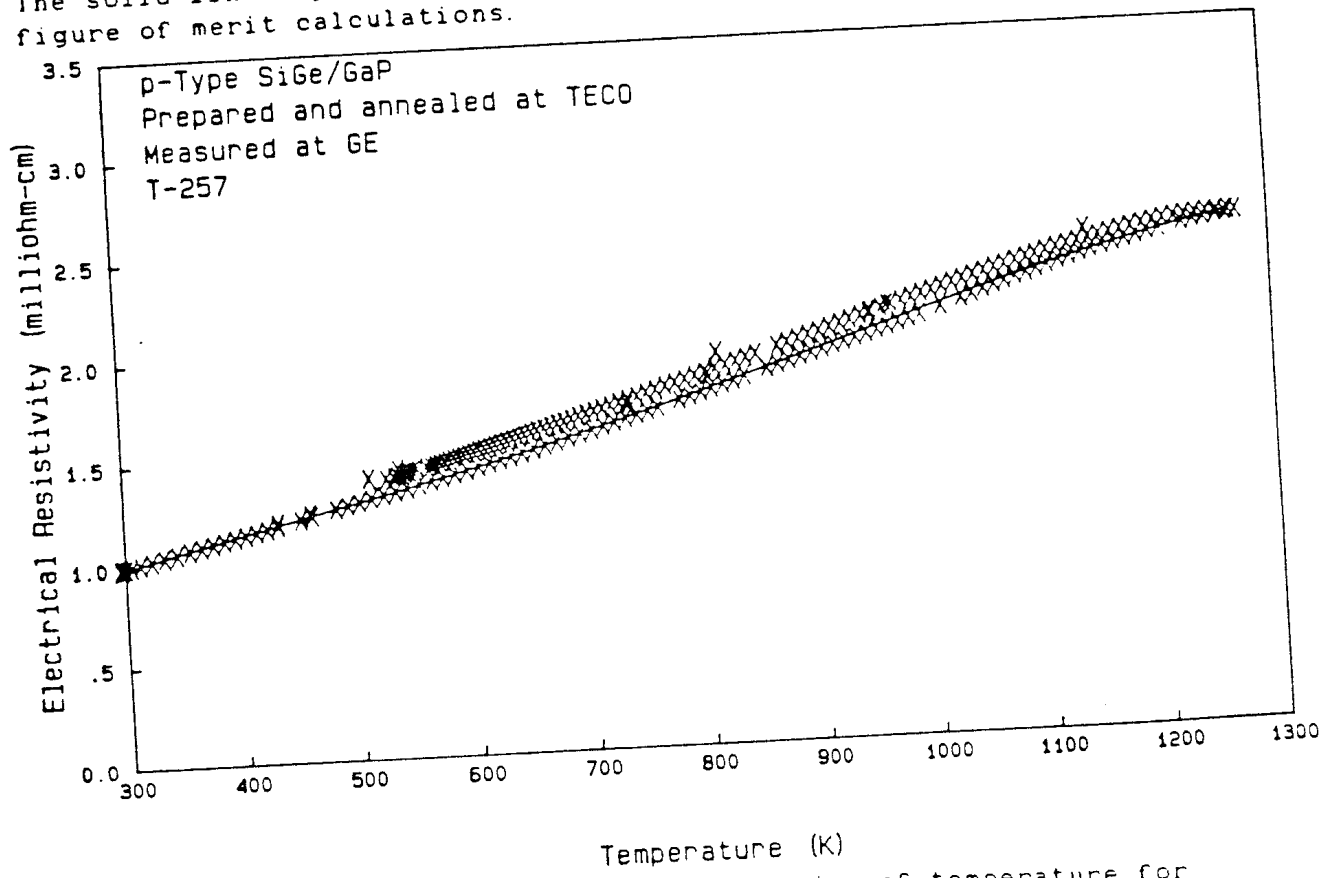


Figure 25 Electrical resistivity as a function of temperature for T-257, p-type SiGe/GaP. Both warming and cooling data are shown. The solid line represents a fit to the warming data used for figure of merit calculations.

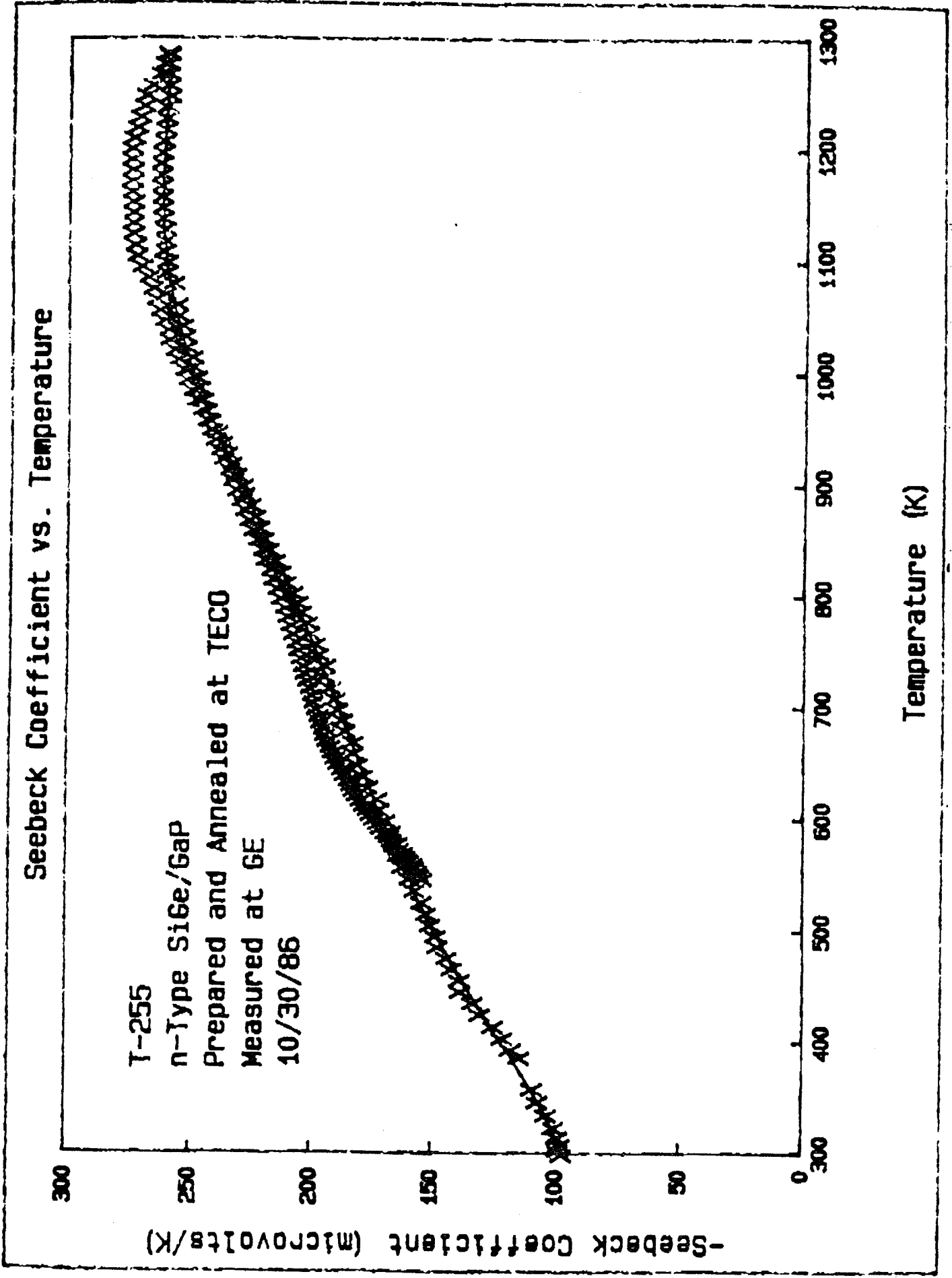
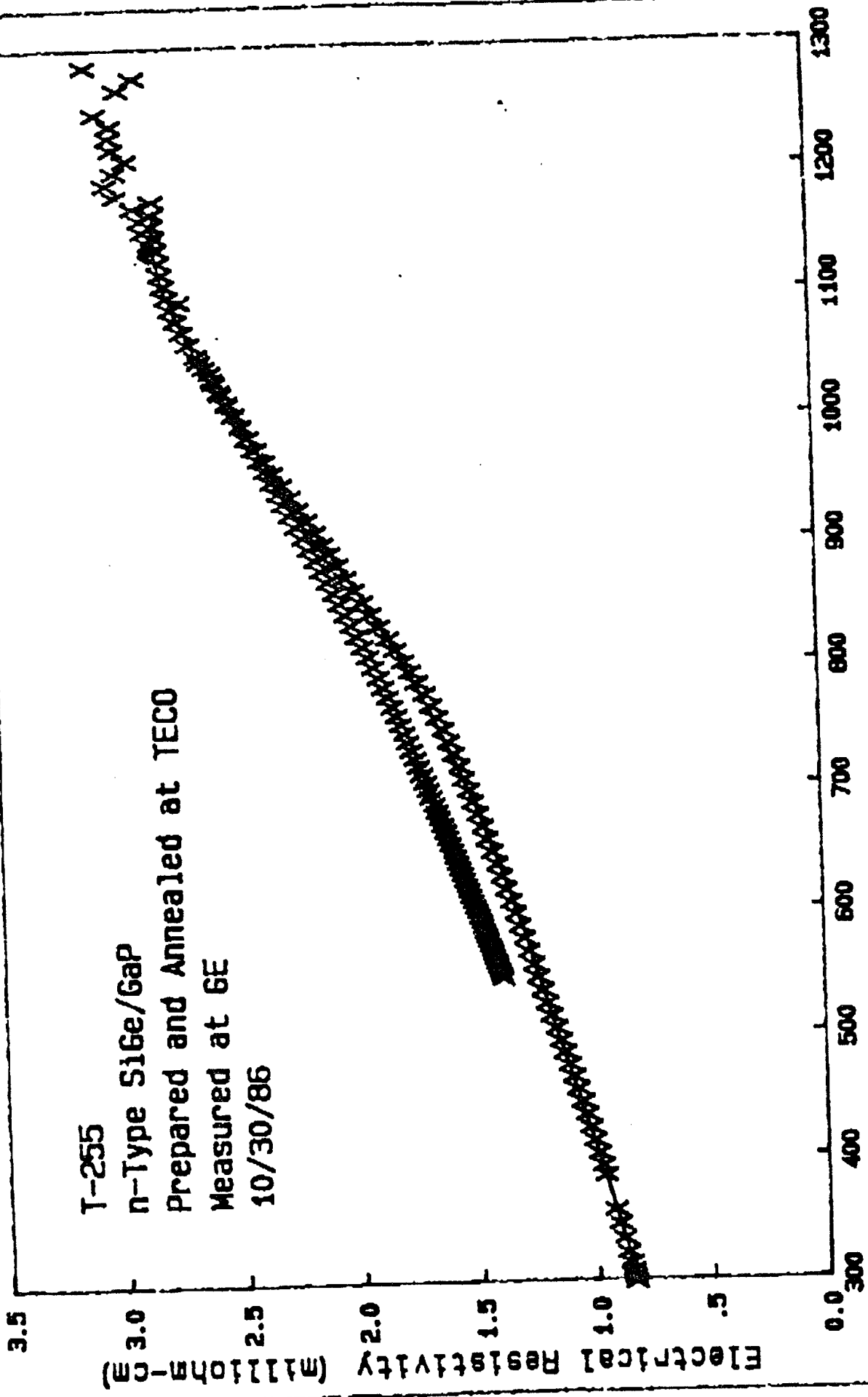


FIGURE 26 HIGH TEMPERATURE SEEBECK COEFFICIENT OF n-TYPE SiGe/GaP, T-255

Electrical Resistivity vs. Temperature



T-255
n-Type SiGe/GaP
Prepared and Annealed at TECO
Measured at GE
10/30/86

Temperature (K)

FIGURE 2.7 HIGH TEMPERATURE ELECTRICAL RESISTIVITY OF T-255, N-TYPE SiGe/GaP

Thermal Diffusivity vs. Temperature

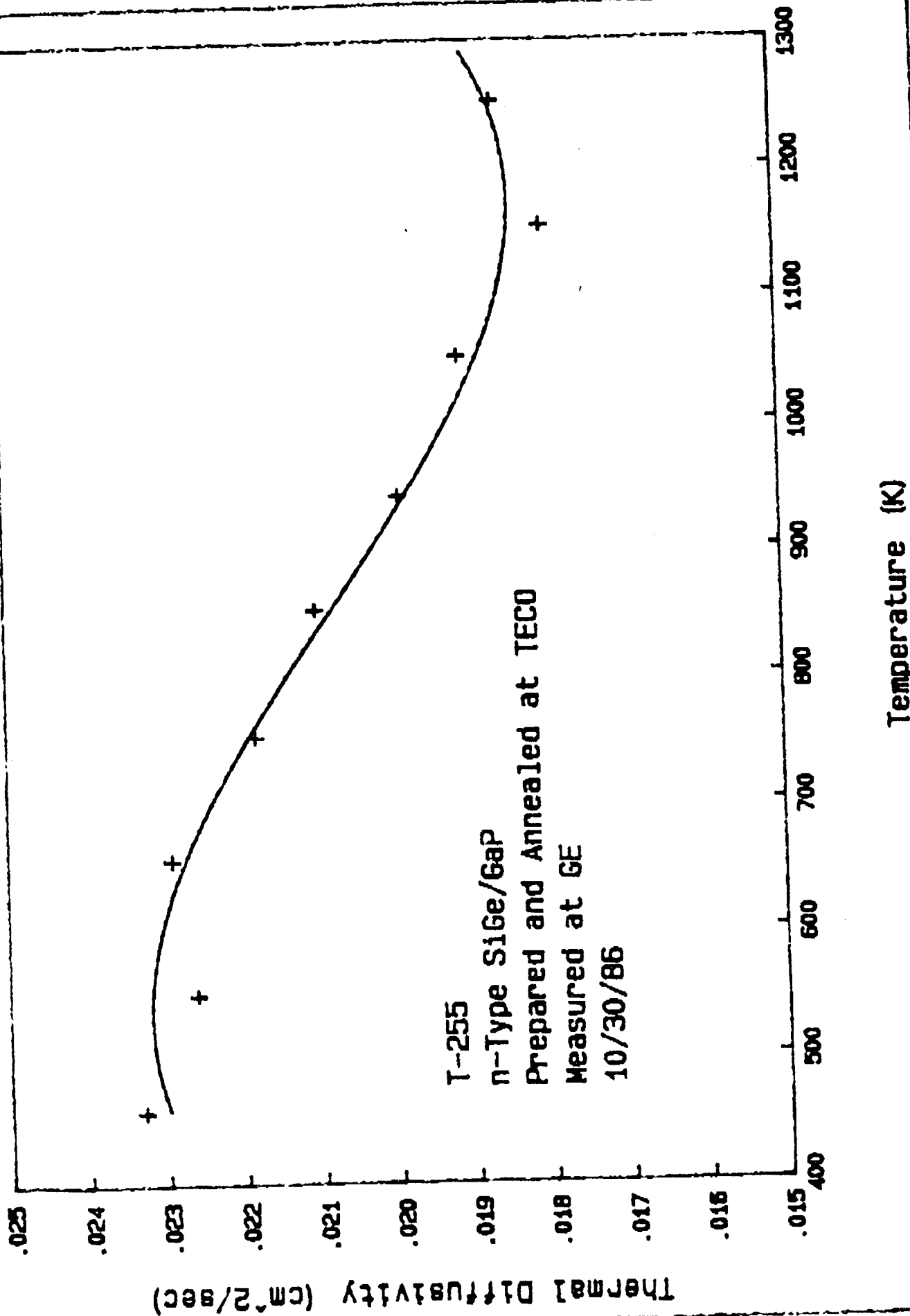


FIGURE 28 HIGH TEMPERATURE THERMAL DIFFUSIVITY OF T-255, n-TYPE SiGe/GaP

TABLE II SUMMARY OF THE THERMOELECTRIC PROPERTIES OF GEP-1 p-TYPE SiGe.

SAMPLE:		GEP1 MOO-RTG Specification p-Type SiGe				Prepared by:	GE		
DESCRIPTION:		SiGe				Measured by:	GE		
Molecular Weight		36.86							
TEMPERATURE	SEEBECK COEFFICIENT	ELECTRICAL RESISTIVITY	THERMAL DIFFUSIVITY	HEAT CAPACITY	DENSITY	THERMAL CONDUCTIVITY	ELECTRICAL POWER FACTOR	FIGURE OF MERIT	DIMENSIONLESS FIGURE OF MERIT
	Seebeck and Resistivity Measured Simultaneously GE-SCD		Laser Flash Diffusivity GE-SCD	Drop Calorimetry Ames Lab. M-PS-077P	Immersion Density Thermal Expansion GE-RSD	Calculated	Calculated	Calculated	Calculated
# Points in Fit	102	106	8	11					
Temp. Range of D	31 C 1017 C	26 C 1017 C	637 K 1378 K	375 K 1375 K					
RMSD (%)	1.16	0.21	0.86	0.93	0.10	1.92	2.54	4.46	4.46
A	1.26226E+02	1.14782E+00	1.37675E-02	4.66300E+00	2.991			Z	ZT
B	1.99675E-01	1.25481E-03	5.33295E-05	1.62220E-03	4.300E-06				
C	2.02748E+06	4.31635E-06	-7.76373E-08	6.31000E+04					
D	-7.69702E-08	-1.13600E-08	3.14982E-11						
E		1.54002E-11		4.184					
F		-7.47247E-15							
G									
H									
Units for Temp:	C	C	K	K	C				K
Equation	A+BT+...HT^7	A+BT+...HT^7	A+BT+...ET^4	D+(A+BT+C/T^2)/M	A/(1+B(T-ZT))^A3	a*Cp+d	S^2/r	S^2/rk	ZT
(K)	(C)	(microV/K)	(milliohm-cm)	(cm2/sec)	(J/g-K)	(g/cm3)	(M/cm-K)	(microM/cm-K2)	(1000/K)
275	Z				0.6747	3.025			
300	Z				0.6642	3.024			
325	52	131.59	1.1844	0.0249	0.6570	3.023		14.62	
350	77	141.54	1.2230	0.0249	0.6523	3.022		15.25	
375	102	146.49	1.2651	0.0248	0.6494	3.021		15.84	
400	127	151.42	1.3100	0.0246	0.6473	3.020		16.36	
425	152	156.31	1.3570	0.0245	0.6478	3.019		16.90	
450	177	161.16	1.4057	0.0243	0.6476	3.018		17.38	
475	202	165.96	1.4557	0.0241	0.6466	3.017		17.84	
500	227	170.71	1.5066	0.0239	0.6501	3.016		18.28	
525	252	175.39	1.5583	0.0236	0.6501	3.015		18.70	
550	277	179.00	1.6105	0.0234	0.6520	3.015	0.0490	19.10	0.3696
575	302	182.57	1.6633	0.0231	0.6543	3.014	0.0490	19.48	0.3974
600	327	186.09	1.7166	0.0229	0.6569	3.013	0.0490	19.84	0.4049
625	352	189.56	1.7703	0.0226	0.6598	3.012	0.0489	20.18	0.4123
650	377	193.05	1.8246	0.0223	0.6628	3.011	0.0488	20.49	0.4196
675	402	197.60	1.8795	0.0221	0.6660	3.010	0.0487	20.78	0.4268
700	427	201.76	1.9352	0.0218	0.6694	3.009	0.0485	21.03	0.4337
725	452	205.80	1.9917	0.0216	0.6732	3.008	0.0483	21.26	0.4402
750	477	209.72	2.0493	0.0214	0.6775	3.007	0.0481	21.46	0.4465
775	502	213.51	2.1079	0.0211	0.6822	3.007	0.0478	21.63	0.4523
800	527	217.17	2.1678	0.0209	0.6873	3.006	0.0475	21.76	0.4575
825	552	220.88	2.2289	0.0206	0.6929	3.005	0.0473	21.85	0.4622
850	577	224.04	2.2915	0.0204	0.6989	3.004	0.0470	21.91	0.4663
875	602	227.25	2.3553	0.0202	0.7053	3.003	0.0467	21.93	0.4696
900	627	230.30	2.4205	0.0200	0.7122	3.002	0.0464	21.91	0.4721
925	652	233.17	2.4869	0.0198	0.7194	3.001	0.0461	21.86	0.4739
950	677	236.86	2.5544	0.0196	0.7270	3.000	0.0459	21.78	0.4747
975	702	239.37	2.6227	0.0194	0.7350	2.999	0.0456	21.66	0.4747
1000	727	240.69	2.6915	0.0192	0.7432	2.998	0.0454	21.52	0.4737
1025	752	242.80	2.7604	0.0190	0.7516	2.997	0.0453	21.36	0.4718
1050	777	244.71	2.8299	0.0188	0.7602	2.996	0.0451	21.17	0.4718
1075	802	246.40	2.8993	0.0186	0.7690	2.995	0.0450	20.96	0.4690
1100	827	247.88	2.9693	0.0184	0.7780	2.994	0.0449	20.74	0.4652
1125	852	249.12	3.0249	0.0182	0.7873	2.993	0.0448	20.52	0.4606
1150	877	250.13	3.0842	0.0180	0.7969	2.992	0.0447	20.29	0.4551
1175	902	250.89	3.1386	0.0178	0.8068	2.991	0.0446	20.06	0.4511
1200	927	251.40	3.1889	0.0176	0.8169	2.990	0.0445	19.83	0.4468
1225	952	251.66	3.2377	0.0174	0.8272	2.989	0.0444	19.62	0.4419
1250	977	251.65	3.2591	0.0172	0.8378	2.988	0.0443	19.43	0.4342
1275	1002	251.37	3.2795	0.0170	0.8487	2.987	0.0442	19.27	0.4261
1300	1027	250.81	3.2988	0.0168	0.8598	2.986	0.0441	19.14	0.4176
		249.96	3.2788	0.0166	0.8711	2.985	0.0440	18.97	0.4089
				0.0164	0.8826	2.984	0.0439	18.83	0.4001
				0.0162	0.8943	2.983	0.0438	18.69	0.5102
				0.0160	0.9062	2.982	0.0437	18.56	0.5114
				0.0158	0.9183	2.981	0.0436	18.43	0.5116
				0.0156	0.9306	2.980	0.0435	18.27	0.5111
				0.0154	0.9431	2.979	0.0434	18.14	0.5102
				0.0152	0.9558	2.978	0.0433	18.06	0.5102
				0.0150	0.9687	2.977	0.0432	0.3915	0.5090
INTEGRATED AVERAGE	241.12	2.8014	0.0212	0.7254	2.996	0.0480	20.91	0.4648	0.4636

500 C TO 1000 C

TABLE 14

SUMMARY OF HIGH TEMPERATURE PROPERTIES OF T-255, n-TYPE SiGe/GaP

SAMPLE: T-255-81 Annealed by program 1
 DESCRIPTION: n-Type SiGe/GaP
 Molecular Weight 37.52

Prepared by: TECO
 Measured by: GE

TEMPERATURE	SEEBECK COEFFICIENT	ELECTRICAL RESISTIVITY	THERMAL DIFFUSIVITY	HEAT CAPACITY	DENSITY	THERMAL CONDUCTIVITY	ELECTRICAL POWER FACTOR	FIGURE OF MERIT	DIMENSIONLESS FIGURE OF MERIT	
	Seebeck and Resistivity Measured Simultaneously GE-SCO		Laser Flash Diffusivity GE-SCO	Drop Calorimetry Asee Lab. MHPs-077P	Immersion Density Thermal Expansion GE-RSO	Calculated	Calculated	Calculated	Calculated	
# Points in Fit	101	95	10	11						
Temp. Range of D	25 C	23 C	458 K	375 K						
	1012 C	903 C	1363 K	1375 K	0.10	2.34	1.63	3.98	3.98	
RMSD (%)	0.62	0.38	1.33	0.93				2	2T	
A	-9.39144E+01	8.13861E-01	7.59077E-03	4.66300E+00	2.989	4.300E-06				
B	-6.98861E-02	9.08426E-04	6.89831E-05	1.62220E-03						
C	-2.11446E-03	5.90912E-06	-9.41154E-08	6.31000E+04						
D	9.13588E-06	-2.24311E-08	3.68043E-11	4.184						
E	-1.73214E-08	3.94523E-11								
F	1.50544E-11	-2.22837E-14								
G	-4.85139E-15									
H										
Units for Temp:	C	C	K	K	C		S ² /r	S ² /rk	K	
Equation	A+BT+...HT ⁷	A+BT+...HT ⁷	A+BT+...ET ⁴	D+(A+BT+C/T ²)/HW	A/(1+B(T-27)) ³	S=Cp/d			2T	
(K)	(C)	(microV/K)	(milliho-cm)	(cm ² /sec)	(J/g-K)	(g/cm ³)	(W/cm-K)	(microW/cm-K ²)	(1000/K)	
275	2	-97.15	0.8421		0.6628	2.990		11.21		
300	27		0.8740		0.6524	2.989		11.92		
325	52	-102.07	0.9097		0.6454	2.988		12.87		
350	77	-108.19	0.9480		0.6407	2.987		13.96		
375	102	-115.02	0.9879		0.6378	2.986		15.11		
400	127	-122.17	1.0287	0.0227	0.6363	2.985		16.26	0.3770	
425	152	-129.35	1.0700	0.0229	0.6358	2.984	0.0431	17.38	0.3994	
450	177	-136.36	1.1115	0.0231	0.6361	2.983	0.0435	18.42	0.4202	
475	202	-143.07	1.1533	0.0232	0.6371	2.982	0.0438	19.36	0.4392	
500	227	-149.42	1.1953	0.0232	0.6386	2.981	0.0441	20.19	0.4562	
525	252	-155.36	1.2378	0.0232	0.6405	2.980	0.0443	20.92	0.4712	
550	277	-160.93	1.2812	0.0231	0.6427	2.979	0.0444	21.55	0.4846	
575	302	-166.15	1.3260	0.0230	0.6453	2.978	0.0445	22.08	0.4964	
600	327	-171.09	1.3724	0.0229	0.6481	2.977	0.0444	22.52	0.5070	
625	352	-175.82	1.4212	0.0228	0.6510	2.977	0.0445	22.90	0.5166	
650	377	-180.42	1.4728	0.0226	0.6542	2.976	0.0443	23.23	0.5257	
675	402	-184.96	1.5277	0.0224	0.6575	2.975	0.0440	23.51	0.5344	
700	427	-189.52	1.5863	0.0222	0.6610	2.974	0.0440	23.76	0.5429	
725	452	-194.15	1.6490	0.0219	0.6645	2.973	0.0438	23.99	0.5514	
750	477	-198.90	1.7160	0.0217	0.6682	2.972	0.0435	24.20	0.5599	
775	502	-203.79	1.7875	0.0214	0.6721	2.971	0.0432	24.40	0.5685	
800	527	-208.84	1.8634	0.0211	0.6757	2.970	0.0429	24.58	0.5772	
825	552	-214.02	1.9434	0.0208	0.6795	2.969	0.0426	24.75	0.5857	
850	577	-219.31	2.0276	0.0205	0.6835	2.968	0.0423	24.89	0.5939	
875	602	-224.67	2.1149	0.0203	0.6874	2.967	0.0419	25.01	0.6017	
900	627	-230.01	2.2044	0.0200	0.6915	2.966	0.0416	25.11	0.6087	
925	652	-235.26	2.2950	0.0197	0.6955	2.965	0.0412	25.16	0.6147	
950	677	-240.32	2.3852	0.0195	0.6996	2.964	0.0409	25.18	0.6195	
975	702	-245.09	2.4733	0.0193	0.7037	2.963	0.0406	25.16	0.6229	
1000	727	-249.46	2.5568	0.0191	0.7079	2.962	0.0404	25.10	0.6248	
1025	752	-253.34	2.6334	0.0189	0.7121	2.961	0.0402	25.01	0.6251	
1050	777	-256.63	2.6999	0.0187	0.7163	2.960	0.0400	24.89	0.6241	
1075	802	-259.25	2.7530	0.0186	0.7205	2.959	0.0399	24.78	0.6219	
1100	827	-261.17	2.7887	0.0185	0.7248	2.958	0.0398	24.68	0.6193	
1125	852	-262.36	2.8027	0.0184	0.7290	2.957	0.0399	24.68	0.6170	
1150	877	-262.86	2.8000	0.0184	0.7333	2.956	0.0400	24.65	0.6170	
1175	902	-262.76	2.8170	0.0184	0.7376	2.956	0.0401	24.66	0.6143	
1200	927	-262.21	2.8340	0.0185	0.7419	2.955	0.0404	24.41	0.6037	
1225	952	-261.46	2.8500	0.0186	0.7463	2.954	0.0408	24.12	0.5909	
1250	977	-260.84	2.8670	0.0188	0.7506	2.953	0.0413	23.87	0.5776	
1275	1002	-260.78		0.0191	0.7549	2.952	0.0420	23.72	0.5653	
1300	1027	-261.84			0.7593	2.951	0.0427		0.7207	
INTEGRATED AVERAGE 500 C TO 1000 C		-245.11	2.446	0.0195	0.7125	2.961	0.0410	24.72	0.6037	0.6196

Table 15 Summary of the high temperature thermoelectric properties of T-257, p-type SiGe/GaP.

SAMPLE: T-257-B Annealed by program 1 Prepared by: TECO
 DESCRIPTION: p-Type SiGe/GaP Measured by: GE
 Molecular Weight 35.05

TEMPERATURE	SEEBECK COEFFICIENT	ELECTRICAL RESISTIVITY	THERMAL DIFFUSIVITY	HEAT CAPACITY	DENSITY	THERMAL CONDUCTIVITY	ELECTRICAL POWER FACTOR	FIGURE OF MERIT	DIMENSIONLESS FIGURE OF MERIT	
	Seebeck and Resistivity Measured Simultaneously GE-SCO		Laser Flash Diffusivity GE-SCO	Drop Calorimetry Area Lab. MHPS-D77P	Immersion Density Thermal Expansion GE-RSO	Calculated	Calculated	Calculated	Calculated	
# Points in Fit	105	106	10	11						
Temp. Range of D	22 C	22 C	447 K	375 K						
	1000 C	1000 C	1352 K	1375 K						
RMSD (%)	0.79	0.95	1.33	0.93	0.10	2.36	2.52	4.88	4.88	
A	9.10183E+01	9.57061E-01	2.08023E-02	4.66300E+00	2.949			Z	ZT	
B	2.64246E-01	1.46961E-03	2.77925E-05	1.62220E-03	4.300E-06					
C	-3.27179E-04	-6.98358E-07	-4.52231E-08	6.31000E+04						
D	3.86576E-07	2.19977E-09	1.83699E-11	4.184						
E	-2.04644E-10	-1.39479E-12								
F										
G										
H										
Units for Temp:	C	C	K	K	C				K	
Equation	A+BT+...HT ⁷	A+BT+...HT ⁷	A+BT+...ET ⁴	D=(A+BT+C/T ²)/MW	A/(1+B(T-27)) ³	a=Cp*d	S ² /r	S ² /rk	ZT	
(K)	(C)	(microV/K)	(cm ² /sec)	(J/g-K)	(g/cm ³)	(W/cm-K)	(microW/cm-K ²)	(1000/K)		
275	2				2.950					
300	27	97.88	0.9961		2.949		9.62			
325	52	103.89	1.0317		2.948		10.46			
350	77	109.56	1.0668		2.947		11.25			
375	102	114.92	1.1017		0.6828	2.946	11.99			
400	127	120.01	1.1364		0.6812	2.945	12.67			
425	152	124.84	1.1711	0.0259	0.6806	2.944	0.0518	13.31	0.2569	
450	177	129.46	1.2059	0.0258	0.6810	2.943	0.0518	13.90	0.2685	
475	202	133.87	1.2410	0.0258	0.6820	2.942	0.0517	14.44	0.2792	
500	227	138.10	1.2765	0.0257	0.6836	2.941	0.0517	14.94	0.2892	
525	252	142.17	1.3124	0.0256	0.6856	2.940	0.0516	15.40	0.2985	
550	277	146.10	1.3489	0.0255	0.6880	2.940	0.0515	15.82	0.3073	
575	302	149.90	1.3860	0.0253	0.6908	2.939	0.0514	16.21	0.3154	
600	327	153.60	1.4237	0.0252	0.6937	2.938	0.0513	16.57	0.3231	
625	352	157.19	1.4621	0.0250	0.6969	2.937	0.0512	16.90	0.3304	
650	377	160.70	1.5013	0.0248	0.7003	2.936	0.0510	17.20	0.3373	
675	402	164.12	1.5412	0.0246	0.7039	2.935	0.0508	17.48	0.3438	
700	427	167.47	1.5819	0.0244	0.7076	2.934	0.0506	17.73	0.3501	
725	452	170.75	1.6233	0.0242	0.7114	2.933	0.0505	17.96	0.3560	
750	477	173.96	1.6654	0.0240	0.7153	2.932	0.0502	18.17	0.3617	
775	502	177.11	1.7083	0.0237	0.7192	2.931	0.0500	18.36	0.3671	
800	527	180.19	1.7517	0.0235	0.7233	2.930	0.0498	18.53	0.3722	
825	552	183.19	1.7957	0.0233	0.7275	2.929	0.0496	18.69	0.3770	
850	577	186.12	1.8402	0.0230	0.7317	2.928	0.0493	18.82	0.3815	
875	602	188.97	1.8851	0.0228	0.7359	2.927	0.0491	18.94	0.3856	
900	627	191.72	1.9303	0.0226	0.7402	2.926	0.0489	19.04	0.3894	
925	652	194.37	1.9757	0.0224	0.7446	2.925	0.0487	19.12	0.3927	
950	677	196.90	2.0212	0.0221	0.7489	2.924	0.0485	19.18	0.3956	
975	702	199.31	2.0666	0.0219	0.7534	2.923	0.0483	19.22	0.3979	
1000	727	201.56	2.1117	0.0217	0.7578	2.923	0.0482	19.24	0.3995	
1025	752	203.65	2.1564	0.0216	0.7623	2.922	0.0480	19.23	0.4005	
1050	777	205.55	2.2006	0.0214	0.7668	2.921	0.0479	19.20	0.4008	
1075	802	207.24	2.2440	0.0212	0.7713	2.920	0.0478	19.14	0.4002	
1100	827	208.70	2.2863	0.0211	0.7759	2.919	0.0478	19.05	0.3986	
1125	852	209.90	2.3275	0.0210	0.7804	2.918	0.0478	18.93	0.3960	
1150	877	210.81	2.3672	0.0209	0.7850	2.917	0.0478	18.77	0.3924	
1175	902	211.40	2.4053	0.0208	0.7896	2.916	0.0479	18.58	0.3875	
1200	927	211.65	2.4414	0.0208	0.7942	2.915	0.0481	18.35	0.3815	
1225	952	211.51	2.4753	0.0208	0.7989	2.914	0.0483	18.07	0.3741	
1250	977	210.94	2.5067	0.0208	0.8035	2.913	0.0486	17.75	0.3653	
1275	1002	209.93	2.5353	0.0208	0.8082	2.912	0.0489	17.38	0.3551	
1300	1027	208.41	2.5608	0.0209	0.8128	2.911	0.0494	16.96	0.3435	
INTEGRATED AVERAGE 500 C TO 1000 C		200.36	2.146	0.0218	0.7627	2.922	0.0485	18.79	0.3875	0.3970

TABLE 17 INTEGRATED AVERAGE VALUES OF THE THERMOELECTRIC PROPERTIES OF SEVERAL SILICON GERMANIUM BASED SAMPLES BETWEEN 500 C AND 1000 C

SAMPLE	S $\mu\text{V}/\text{K}$	R $\text{m}\Omega\text{-cm}$	K $\text{mW}/\text{cm-K}$	S^2/R $\mu\text{W}/\text{cm-K}^2$	Z $10\text{E}-3/\text{K}$	ZT
<u>p-type SiGe prepared to current MOD-RTG specifications</u>						
GEP-1	241	2.80	46.0	20.9	0.455	0.464
GEP-2	234	2.78	44.8	19.8	0.443	0.452
GEP-3	237	2.60	45.6	21.7	0.476	0.487
mean	237	2.73	45.5	20.8	0.458	0.468
standard deviation	+1.5%	+4.0%	+1.3%	+4.5%	+3.6%	+3.8%
<u>p-type SiGe/GaP prepared by Thermo Electron</u>						
T-257	200	2.15	48.5	18.8	0.388	0.397
<u>n-type SiGe prepared to current MOD-RTG specifications</u> (prepared and characterized under another program)						
ITM-130	-245	1.95	40.4	30.9	0.770	0.789
<u>n-type SiGe/GaP prepared by Thermo Electron</u>						
T-255	-245	2.45	41.0	24.7	0.604	0.620
remeasurement of electrical properties of T-255						
T-255	-255	2.63	41.0	25.1	0.614	0.629