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APRIL 1968

THE THERMODYNAMICS OF THE SILICON CARBIDE/SILICON-CARBON VAPOR SYSTEM

F. J. Krieger

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JUN 1 2 1968

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PREPARED FOR:
UNITED STATES AIR FORCE PROJECT RAND

The RAND Corporation
SANTA MONICA • CALIFORNIA

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The RAND *Corporation*

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PREFACE

This RAND Memorandum is a continuation of a broad study originally
requested in 1962 by the Scientific Advisor to the Physics Division,
Research Directorate,[*] Air Force Special Weapons Center, Kirtland
Air Force Base, New Mexico.

It is a contribution to a better understanding of the complex
problems involved in the physics of reentry bodies. Silicon carbide
is the fourteenth of a series of ablative materials to be investigated
by means of mathematical techniques similar to those used at RAND in
the parametric study of certain low-molecular-weight compounds as
nuclear rocket propellants.

The results of the investigation of graphite, polystyrene, poly-
ethylene, phenol-formaldehyde resin, polyamide resin, teflon, silica,
zirconia, magnesia, alumina, beryllia, calcia, and magnesium silicate,
the first thirteen materials to be studied in the series, are reported
in RAND Memoranda RM-3326-1-PR, _The Thermodynamics of the Graphite/_
Carbon Vapor System; RM-3708-PR, _The Thermodynamics of the Polystyrene/_
Hydrocarbon Vapor System; RM-3709-PR, _The Thermodynamics of the Poly-_
ethylene/Hydrocarbon Vapor System; RM-3988-PR, _The Thermodynamics of_
the Phenol-Formaldehyde Resin/Carbon-Hydrogen-Oxygen Vapor System;
RM-4404-PR, _The Thermodynamics of the Polyamide Resin (Nylon-6)/Carbon-_
Hydrogen-Oxygen-Nitrogen Vapor System; RM-4634-PR, _The Thermodynamics_
of the Teflon/Fluorocarbon Vapor System; RM-4804-PR, _The Thermodynamics_
of the Silica/Silicon-Oxygen Vapor System; RM-4907-PR, _The Thermo-_
dynamics of the Zirconia/Zirconium-Oxygen Vapor System; RM-4943-PR,
The Thermodynamics of the Magnesia/Magnesium-Oxygen Vapor System;
RM-5043-PR, _The Thermodynamics of the Alumina/Aluminum-Oxygen Vapor_
System; RM-5151-PR, _The Thermodynamics of the Beryllia/Beryllium-Oxygen_
Vapor System; RM-5248-PR, _The Thermodynamics of the Calcia/Calcium-_
Oxygen Vapor System; and RM-5337-PR, _The Thermodynamics of the Magnesium_
Silicate/Magnesium-Silicon-Oxygen Vapor System.

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[*] Now the Air Force Weapons Laboratory.

SUMMARY

The purpose of this study is the thermodynamic investigation of silicon carbide, SiC, over a range of temperatures up to 6000°K and pressures up to 10^3 atmospheres.

Two sets of equilibrium composition equations are used--one representing a pure gas phase, the other a heterogeneous system of gas and condensed (i.e., solid) silicon carbide. The gas phase of the heterogeneous chemical system, like the homogeneous gas phase, comprises 25 gaseous silicon-carbon species.

The results of the computational program are presented in both tabular and graphic form. The latter is a conventional Mollier diagram in which specific enthalpy is plotted against specific entropy, with cross plots of temperature, pressure, and molecular weight or moles of condensed silicon carbide.

CONTENTS

I. INTRODUCTION

This study considers a chemical system that under certain conditions of temperature and pressure is a pure gas mixture and under others is a disperse system, i.e., smoke. In this case the smoke is a gas that contains a condensed phase, solid silicon carbide, symbolized by SiC.

The following assumptions were made in the computations:

(1) Thermal equilibrium is maintained between the condensed particles and the gas phase.

(2) The pressure due to the thermal motion of the condensed particles can be neglected.

(3) The gas phase obeys the ideal-gas law.

(4) The volume coefficient of thermal expansion of the condensed phase is constant.

(5) The solid phase is cubic, or beta, silicon carbide.

(6) Silicon carbide does not decompose at $3259^\circ K$.

II. COMPOSITION EQUATIONS

In this study it is assumed that the gas formed by heating silicon carbide, SiC, at various pressures up to a temperature of $6000°K$ is a mixture involving twenty-five gaseous chemical species-- C, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, e^-, C^-, C_2^-, C^+, C^{+2}, C^{+3}, C^{+4}, C^{+5}, C^{+6}, SiC, Si_2C, SiC_2, Si, Si_2, Si_3--and one condensed species--SiC (solid). The presence or absence of a condensed phase makes it necessary to consider two distinct sets of chemical equations.

A. No condensed phase present. In terms of Si, C, and e^- as primary components 1, 2, and 3, the chemical equations for the secondary components, or derived species, are given by the expression

$$a_i Si + b_i C + c_i e^- = Si_{a_i} C_{b_i} e^-_{c_i}, \qquad (1)$$
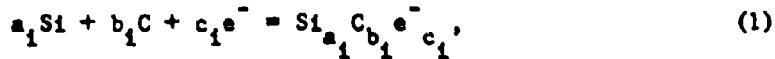
where the coefficients a_i, b_i, and c_i have the following values:

<div align="center">

Component i

a_i	b_i	c_i	Symbol	Number
	2		C_2	4
	3		C_3	5
	4		C_4	6
	5		C_5	7
	6		C_6	8
	7		C_7	9
	8		C_8	10
	9		C_9	11
	10		C_{10}	12
	1	1	C^-	13
	2	1	C_2^-	14
	1	-1	C^+	15
	1	-2	C^{+2}	16
	1	-3	C^{+3}	17

</div>

<u>Component i</u>

a_i	b_i	c_i	Symbol	Number
	1	-4	C^{+4}	18
	1	-5	C^{+5}	19
	1	-6	C^{+6}	20
1	1		SiC	21
2	1		Si_2C	22
1	2		SiC_2	23
2			Si_2	24
3			Si_3	25

The mass-balance equations are

$$n_{Si} = 1 - \sum_4^{25} a_i n_i, \tag{2}$$

$$n_C = 1 - \sum_4^{25} b_i n_i, \tag{3}$$

and

$$n_{e^-} = - \sum_4^{25} c_i n_i, \tag{4}$$

where n_{Si}, n_C, and n_{e^-} are the numbers of moles of Si, C, and e^-, respectively, a_i, b_i, and c_i are the coefficients of Si, C, and e^-, on the left-hand side of Eq. (1), and n_i is the corresponding number of moles of component i.

The equilibrium equations are given by the expression

$$n_i = K_i (P/n)^{a_i + b_i + c_i - 1} (n_{Si})^{a_i} (n_C)^{b_i} (n_{e^-})^{c_i}, \tag{5}$$

where n is the total number of moles of gas in the equilibrium
mixture, P is the total pressure in atmospheres, and K_i is the
thermodynamic equilibrium constant of component i computed on the
basis of Eq. (1).

    B. **Solid SiC present**. In terms of **SiC** (solid), C, and e^- as
primary components 1, 2, and 3, the secondary components, or derived
species, may be obtained from the following generalized chemical
equation:

$$a_j SiC + b_j C + c_j e^- = Si_{a_j} C_{b_j} e^-_{c_j} . \tag{6}$$
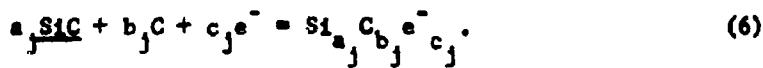
The coefficients a_j, b_j, and c_j, as well as the corresponding
derived species, are listed in the following table.

a_j	b_j	c_j	Component j Symbol	Number
	2		C_2	4
	3		C_3	5
	4		C_4	6
	5		C_5	7
	6		C_6	8
	7		C_7	9
	8		C_8	10
	9		C_9	11
	10		C_{10}	12
	1	1	C^-	13
	2	1	C_2^-	14
	1	-1	C^+	15
	1	-2	C^{+2}	16
	1	-3	C^{+3}	17
	1	-4	C^{+4}	18
	1	-5	C^{+5}	19
	1	-6	C^{+6}	0

a_j	b_j	c_j	Component j Symbol	Number
1			SiC	21
2	-1		Si_2C	22
1	1		SiC_2	23
1	-1		Si	24
2	-2		Si_2	25
3	-3		Si_3	26

The mass-balance equations are

$$n_{\underline{SiC}} = 1 - \sum_4^{26} a_j n_j, \tag{7}$$

$$n_C = - \sum_4^{26} b_j n_j, \tag{8}$$

and

$$n_{e^-} = - \sum_4^{26} c_j n_j, \tag{9}$$

where $n_{\underline{SiC}}$, n_C, and n_{e^-} are the numbers of moles of $\underline{SiC}$, C, and e^-, respectively, a_j, b_j, and c_j are the coefficients of $\underline{SiC}$, C, and e^-, in Eq. (6), and n_j is the corresponding number of moles of component j.

The equilibrium equations are obtained by considering the free energy F of the system and the partial molar free energy, or chemical potential, $\mu_x = \partial F/\partial n_x$ of each component. For an ideal gas

$$\mu_x = \mu_x^O + RT \ln (n_x P/n), \tag{10}$$

where μ_x^O is the chemical potential of component x in the standard state of unit partial pressure, R is the gas constant, T is the temperature, P is the pressure, and n is the total number of moles

of gaseous species in the mixture. The chemical potential for SiC
is given by

$$\mu_{SiC} = \mu^o_{SiC} + (P - 1)\bar{V}_{SiC},$$ (11)

where μ^o_{SiC} is the standard molar free energy for SiC, $\bar{V}_{SiC}$ is the
molar volume of SiC, and P is the pressure of the system.

By combining Eqs. (10) and (11), keeping in mind that the
subscript j refers to the derived species on the right-hand side of
Eq. (6), the following expression is obtained

$$n_j = K_j \exp\left[a_j(P - 1)\bar{V}_{SiC}/RT\right] (P/n)^{b_j+c_j-1} (n_C)^{b_j}(n_{e^-})^{c_j}.$$ (12)

In Eq. (12), K_j is the thermodynamic equilibrium constant associated
with the chemical reaction of Eq. (6) and is defined by the relation

$$\Delta F^o = \mu^o_j - a_j\mu^o_{SiC} - b_j\mu^o_C - c_j\mu^o_{e^-} = -RT \ln K_j.$$ (13)

At first glance, Eqs. (7), (8), (9), and (12) represent a
mathematical system of twenty-five equations in twenty-five unknowns
that, ordinarily, could be solved by simple iteration. From the
standpoint of the Gibbs phase rule, however, the chemical system
under consideration, consisting of one component and two phases,
enjoys but one degree of freedom. This means that at an arbitrarily
fixed temperature, solid and vapor are in equilibrium at a unique
pressure which can be determined in the following manner.

The expression for the total pressure as the sum of the partial
pressures is

$$P = \sum_{2}^{26} n_x P/n,$$ (14)

where n is the total number of moles of gas in the equilibrium mixture.
In view of Eq. (12) the above expression becomes

$$P = P_C + P_{e^-} + \sum_{4}^{26} K_j (\exp a_j Q) (P_C)^{b_j} (P_{e^-})^{c_j}, \tag{15}$$

where P_C and P_{e^-} are the partial pressures of C and e^-, respectively,
and Q represents the quantity $(P - 1)\bar{V}_{\underline{SiC}}/RT$. In like manner,
Eqs. (8) and (9), when multiplied through by P/n and rearranged,
become

$$\emptyset = P_C + \sum_{4}^{26} b_j K_j (\exp a_j Q) (P_C)^{b_j} (P_{e^-})^{c_j}, \tag{16}$$

and

$$\emptyset = P_{e^-} + \sum_{4}^{26} c_j K_j (\exp a_j Q) (P_C)^{b_j} (P_{e^-})^{c_j}, \tag{17}$$

where $\emptyset$ represents zero. Equations (15), (16), and (17) represent
a system of three equations in three unknowns, P, P_C, and P_{e^-}, which
can be solved by iteration. It is then a simple matter to solve for
P_j, n_j, and n.

III. THERMODYNAMIC EQUATIONS

The molecular weight of the gas-SiC mixture is given by the relation

$$M = \frac{40.097}{\bar{n}},\qquad(18)$$

where 40.097 is the formula weight of the input material SiC and $\bar{n}$ is the total number of moles in the mixture.

The specific free energy (in calories per gram) of the mixture is given by the expression

$$f = \frac{1}{40.097}\left\{\sum^{g} n_i \left[\mu_i^o + RT \ln (n_i P/n)\right] + n_{SiC}\left[\mu_{SiC}^o + c(P - 1)\bar{V}_{SiC}\right]\right\},\qquad(19)$$

which is derived from Eqs. (5) and (6). The summation is over all gaseous species. The constant $c = 0.0242172$ converts cc-atmospheres to calories.

The specific entropy (in calories per degree per gram) of the mixture is given by the expression

$$s = \frac{1}{40.097}\left\{\sum^{g} n_i \left[S_i^o - R \ln (n_i P/n)\right] + n_{SiC}\left[s_{SiC}^o - c\alpha_v (P - 1)\bar{V}_{SiC}\right]\right\},\qquad(20)$$

where S_i^o and S_{SiC}^o are the standard molar entropy of component i and SiC, respectively, at a given temperature, and α_v is the volume coefficient of thermal expansion of SiC.

The specific enthalpy (in calories per gram) of the gas mixture is given by the expression

$$h = \frac{1}{40.097}\left\{\sum^{g} n_i H_i^o + n_{SiC}\left[H_{SiC}^o + c(1 - \alpha_v T)(P - 1)\bar{V}_{SiC}\right]\right\},\qquad(21)$$

where H_i^O and $H_{\underline{SiC}}^O$ are the standard molar heat content of component i and $\underline{SiC}$, respectively, at a given temperature.

The specific internal energy (in calories per gram) of the mixture is given by the expression

$$u = \frac{1}{40.097} \left\{ \sum^g n_i (H_i^O - RT) + n_{\underline{SiC}} \left[H_{\underline{SiC}}^O - c[1 + (P - 1)\alpha_v T]\bar{V}_{\underline{SiC}} \right] \right\} .$$

(22)

The terms representing the increase in a thermodynamic property from one atmosphere to P atmospheres for $\underline{SiC}$, namely,

$$\Delta F = (P - 1)\bar{V}_{\underline{SiC}},$$

(23)

$$\Delta S = - \alpha_v (P - 1)\bar{V}_{\underline{SiC}},$$

(24)

$$\Delta H = (1 - \alpha_v T)(P - 1)\bar{V}_{\underline{SiC}},$$

(25)

$$\Delta U = - \alpha_v T(P - 1)\bar{V}_{\underline{SiC}},$$

(26)

are readily derived from the differential formulas relating the various thermodynamic functions. Each of the above terms must be multiplied by the factor c = 0.0242172 to convert it from cc-atmospheres to calories.

The specific volume of the mixture (in cubic centimeters per gram) is given by the expression

$$v = \frac{1}{40.097} \left\{ nRT/P + n_{\underline{SiC}}\bar{V}_{\underline{SiC}} \right\} ,$$

(27)

where the first term in the braces is the volume of the gas phase and the second term is that of the condensed phase.

IV. BASIC DATA

The pertinent thermodynamic properties (heat content, entropy, free energy, and heat of formation) for this study were taken from three sources: JANAF Thermochemical Data,[1] Duff and Bauer,[2] and F. R. Gilmore.[3] The molecular weights and heats of formation of the various components are listed in the following table.

Species	Molecular Weight	Heat of Formation at $0°K$ (cal/mole)	Reference
$SiC(\beta,s)$	40.097	-17,261	1
$SiC(g)$	40.097	170,806	1
Si_2C	68.183	127,068	1
SiC_2	52.108	145,631	1
Si	28.086	106,664	1
Si_2	56.172	140,324	1
Si_3	84.258	151,219	1
C	12.011	169,576	1
C_2	24.022	197,000	1
C_3	36.033	188,104	1
C_4	48.044	240,500	1
C_5	60.055	240,298	1
C_6	72.066	287,000	2
C_7	84.077	287,000	2
C_8	96.088	339,000	2
C_9	108.099	334,000	2
C_{10}	120.110	393,000	2
e^-	0.0005489	0	1
C^-	12.0115	140,800	1
C_2^-	24.0225	125,500	1
C^+	12.0105	429,623	3
C^{+2}	12.0099	991,894	3
C^{+3}	12.0094	2,096,127	3
C^{+4}	12.0088	3,583,375	3
C^{+5}	12.0083	12,625,199	3
C^{+6}	12.0077	23,924,616	3

The molar volume of solid SiC ($\tilde{V}_{SiC}$ = 12.5 cc) was derived from a mean density of 3.21 gm/cc.

The volume coefficient of thermal expansion for silicon carbide is

$$\alpha_v = \frac{1}{v}\left[\frac{\partial v}{\partial T}\right]_p = 14.1 \times 10^{-6} \text{ cc/cc-deg.}$$

This value was derived from the linear coefficient of thermal expansion for silicon carbide given in Ref. 4 for the temperature range 20-800°C.

Two values of the gas constant were used: R = 1.98716 cal/deg-mole and R = 82.0557 cc-atm/deg-mole. Their ratio gives the conversion factor c = 0.0242172.

V. COMPUTATIONAL PROCEDURE

The two sets of equilibrium composition equations--the one involving condensed SiC and the other the gaseous species only-- represent two mutually exclusive contiguous regions. It is expedient to determine the border line between the two regions, that is, the conditions of temperature and pressure under which the condensed species just vanishes. This can be done in the following manner.

Since $n_{SiC} = 0$ along the gas/condensate interface, it follows that Eqs. (5) and (12) are identical for this condition. Hence, for a particular species, say SiC (g), combining Eqs. (5) and (12) gives the relation

$$n_{Si}n_C(P/n)^2 = (K^6_{SiC}/K^1_{SiC}) \exp\left[(P - 1)\ddot{V}_{SiC}/RT\right], \qquad (28)$$

where the equilibrium constants K^1_{SiC} and K^6_{SiC} are computed on the basis of Eqs. (1) and (6), respectively. Now, if each side of Eq. (28) is plotted against pressure for an arbitrary temperature, the result is a graph of two curves that intersect at a unique pressure.

VI. RESULTS

The results of this study are presented numerically in Tables 1 and 2 and graphically in Figs. 1 through 4. Figure 1--as well as its detail, Fig. 2--is a conventional Mollier diagram for silicon carbide; specific enthalpy is plotted against specific entropy, with cross plots of temperature, pressure, and molecular weight in the pure gas region, and cross plots of temperature and moles of condensed SiC in the gas-solid region. The broken line demarcates the pure gas phase (above) from the smoke (below). The absence of a discontinuity at $3259^\circ K$ (the temperature at which β-SiC is supposed to decompose at 1 atm) is due to the lack of experimental data concerning the solubility of graphite in liquid silicon at and above this temperature.

Figure 3 is a plot of volume versus temperature with cross plots of constant pressure and moles of condensed SiC.

The variation of sublimation temperature with pressure for silicon carbide and graphite is shown in Fig. 4. For silicon carbide at 10^{-3} atm the sublimation temperature is $2483^\circ K$, at 1 atm it is $3259^\circ K$, while at 10^2 atm it is $4096^\circ K$. The corresponding temperatures for graphite are $3150^\circ K$, $4127^\circ K$, and $5170^\circ K$, respectively.[5]

All the computations required to obtain the results in Tables 1 and 2 were made on the RAND IBM 7040/7044 computer. In the tables the numbers are represented in "floating decimal" notation; the first five digits indicate the decimal form of the number, and the last two digits indicate a power of 10. Thus, 12345 05 represents 0.12345×10^5 and 12345-05 represents 0.12345×10^{-5}.

Table 1

SUMMARY OF COMPUTED VALUES OF VOLUME, MOLECULAR WEIGHT, MOLES OF GAS,
AND MOLES OF SOLID SiC FOR SILICON CARBIDE AT VARIOUS
TEMPERATURES AND PRESSURES

Temperature, T (°K)	Pressure, P (atm)	Log Volume, v (cc/gm)	Molecular Weight, M	Moles of Gas, n	Moles of SiC
6000 04	1C000-07	12565 02	13403 02	29916 01	
6C00 04	100CC-06	11555 02	13707 02	29252 01	
6CC0 04	1CCC0-C5	1C508 02	15289 02	26225 01	
6CC0 04	1C0C0-04	94425 01	17771 02	22563 01	
6000 04	1C000-03	84085 01	19218 02	20864 01	
6000 04	1CCCC-02	73962 01	19774 02	20278 01	
6CC0 04	1CCC0-01	63920 01	19963 02	20085 01	
60C0 04	1CCCC CC	539C1 01	20050 02	19998 01	
6C00 04	1CC00 01	43841 01	20333 02	19720 01	
6C00 04	100C0 02	33370 01	22658 02	17696 01	
6CC0 04	1CCCC C3	21832 01	32293 02	12417 01	
60C0 04	1CGCC 04	1C454 C1	44348 02	90414 00	
5SC0 04	1CCC0-07	12519 02	13674 02	29323 01	
55C0 04	1C0CC-06	11473 02	15172 02	26429 01	
5500 04	1C0C0-05	1C407 02	17668 02	22694 01	
5500 04	1C000-04	93718 01	19174 02	20912 01	
5500 04	1C000-03	83587 01	19758 02	20294 01	
5500 04	1CC0C-02	73544 01	19956 02	20092 01	
5500 04	1CC0C-01	63528 01	20028 02	20021 01	
55C0 04	10000 0C	53507 01	20126 02	19923 01	
5500 04	1C000 01	43342 01	20905 02	19180 01	
5500 04	1C0CC C2	32335 01	26363 02	15210 01	
5500 04	1CC0C 03	20774 01	37766 C2	10617 01	
55C0 04	1C000 04	97013 00	48343 02	82942 00	
5CC0 04	1C000-C7	12423 02	15500 02	25868 01	
5C00 04	1C000-06	11359 02	17943 02	22347 01	
5CC0 04	1CCCC-05	1C328 02	19291 02	20786 01	
50C0 04	1CC00-04	93164 01	19799 02	2C252 01	
5CCC 04	1C00C-03	83127 01	19969 02	2C080 01	
5C00 04	10000-02	73115 01	20026 02	20022 01	
5CC0 04	1CCCC-01	631C5 01	20073 02	19976 01	
5000 04	1CCC0 C0	53040 01	20372 02	19682 01	
5CC0 04	1CCCC 01	42494 01	23106 02	17354 01	
5CC0 04	1C00C 02	3C968 01	32828 02	12214 01	
5CC0 04	1CCCC C3	198C1 01	42947 02	93363 00	

Table 1--continued

Temperature, T (°K)	Pressure, P (atm)	Log Volume, v (cc/gm)	Molecular Weight, M	Moles of Gas, n	Moles of SiC
5000 04	1C000 04	89569 CC	52166 02	76864 00	
5C00 04	3CC44 04	39355 00	55179.02	72668 00	-55879-08
5C00 04	3C044 04	35383 00	53179 02	65401 00	10000 00
5CC0 04	3C044 04	31010 00	51318 02	58134 00	20000 00
5C00 04	30044 04	26148 00	49584 02	50867 00	30000 00
5C00 04	3C044 04	20672 CC	47963 02	43601 00	40000 00
5C00 04	30044 04	14404 00	46444 02	36334 00	50000 U0
5C00 04	3CC44 C4	70765-01	45019 02	29067 00	60000 U0
5C00 04	30044 04	-17431-01	43679 02	21800 00	70000 00
5C00 04	3C044 04	-12823 C0	42416 02	14534 00	8C000 00
5000 04	3C044 04	-27734 00	41224 02	72668-01	9C000 0C
5C00 04	3C044 C4	-47710 00	40207 02	72668-02	99000 00
5000 04	3C044 04	-5C323 00	40108 02	72668-03	99900 U0
5C00 04	3CC44 C4	-50593 0C	40098 02	72668-04	99990 00
5000 04	30044 04	-50620 00	40097 02	72668-05	99999 00
4500 04	1CCC0-C7	12298 02	18586 02	21574 01	
45C0 04	1CCCC-06	11276 02	19545 02	20515 01	
45C0 C4	1C0C0-C5	1C269 02	19885 02	20164 01	
4500 04	1C000-04	92664 01	19997 02	20052 0i	
4500 04	1CC00-03	82656 01	20034 02	2CC15 01	
4500 U4	1CCCC-02	72650 01	20059 02	19989 01	
45C0 04	1C00C-01	62617 01	20211 02	19840 01	
4500 04	10000 00	52294 01	21773 02	18416 01	
4500 04	1CCC0 01	4C937 01	29762 02	13473 01	
4500 04	1CCC0 02	29729 01	39307 02	10201 01	
4500 04	1CCCC 03	18845 01	48170 02	83240 00	
4500 04	51832 03	11209 01	53933 02	74346 00	-97789-08
4500 04	51832 03	1C762 01	52134 02	66912 00	10000 0C
4500 04	51832 03	1C265 01	50451 02	59477 00	20000 00
4500 04	51832 03	97034 C0	48874 02	52042 00	30000 U0
4500 04	51832 03	90580 00	47392 02	4460R C0	40000 00
45C0 04	51832 C3	82997 C0	45997 02	37173 00	50000 0C
45C0 04	5x832 03	73804 0C	44682 02	29739 00	60000 U0
45C0 04	51832 03	62127 CC	43440 02	22304 00	70000 00
4500 04	51032 C3	46107 00	42266 02	14869 00	80000 00
45C0 04	51832 03	2C451 CC	41153 02	74346-01	90000 00
45C0 04	51832 C3	-35586 00	40200 02	74346-02	99000 00
45C0 04	51832 03	-48863 C0	40107 02	74346-03	59900 00
4500 04	51832 C3	-50444 00	40098 02	74346-04	99990 0C
4500 04	51832 03	-5C605 CC	40097 02	74346-05	99999 0U

Table 1--continued

Temperature, T (°K)	Pressure, P (atm)	Log Volume, v (cc/gm)	Molecular Weight, M	Moles of Gas, n	Moles of SiC
4000 04	10000-07	12219 02	19820 02	20231 01	
4000 04	10000-06	11216 02	19975 02	20073 01	
4000 04	10000-05	10215 02	20025 02	20023 01	
4000 04	10000-04	92142 01	20042 02	20006 01	
4000 04	10000-03	82139 01	20058 02	19990 01	
4000 04	10000-02	72114 01	20173 02	19877 01	
4000 04	10000-01	61840 01	21486 02	18662 01	
4000 04	10000 00	50549 01	28926 02	13862 01	
4000 04	10000 01	39380 01	37863 02	10590 01	
4000 04	10000 02	28624 01	45054 02	88997 00	
4000 04	64751 02	19870 01	52230 02	76771 00	-12340-07
4000 04	64751 02	19414 01	50696 02	69094 00	10000 00
4000 04	64751 02	18904 01	49249 02	61416 00	20000 00
4000 04	64751 02	18327 01	47883 02	53739 00	30000 00
4000 04	64751 02	17661 01	46591 02	46062 00	40000 00
4000 04	64751 02	16874 01	45366 02	38385 00	50000 00
4000 04	64751 02	15912 01	44205 02	30708 00	60000 00
4000 04	64751 02	14674 01	43101 02	23031 00	70000 00
4000 04	64751 02	12936 01	42051 02	15354 00	80000 00
4000 04	64751 02	99938 00	41051 02	76771-01	90000 00
4000 04	64751 02	10691 00	40191 02	76771-02	99000 00
4000 04	64751 02	-38885 00	40106 02	76771-03	99900 00
4000 04	64751 02	-49296 00	40098 02	76771-04	99990 00
4000 04	64751 02	-50489 00	40097 02	76771-05	99999 00
3500 04	10000-07	12157 02	20029 02	20019 01	
3500 04	10000-06	11156 02	20043 02	20006 01	
3500 04	10000-05	10156 02	20048 02	20000 01	
3500 04	10000-04	91558 01	20064 02	19984 01	
3500 04	10000-03	81522 01	20228 02	19822 01	
3500 04	10000-02	71084 01	22374 02	17922 01	
3500 04	10000-01	59701 01	30768 02	13032 01	
3500 04	10000 00	48752 01	38278 02	10475 01	
3500 04	10000 01	38162 01	43849 02	91443 00	
3500 04	46702 01	30929 01	49649 02	80761 00	-73342-08
3500 04	46702 01	30472 01	48494 02	72685 00	10000 00
3500 04	46702 01	29960 01	47391 02	64609 00	20000 00
3500 04	46702 01	29381 01	46338 02	56533 00	30000 00
3500 04	46702 01	28712 01	45330 02	48457 00	40000 00
3500 04	46702 01	27920 01	44365 02	40381 00	50000 00
3500 04	46702 01	26952 01	43440 02	32304 00	60000 00
3500 04	46702 01	25703 01	42553 02	24228 00	70000 00

Table 1--continued

Temperature, T (°K)	Pressure, P (atm)	Log Volume, v (cc/gm)	Molecular Weight, M	Moles of Gas, n	Moles of SiC
3500 04	46702 01	23944 01	41702 02	16152 00	80000 00
3500 04	46702 01	20939 01	40884 02	80761-01	90000 00
3500 04	46702 01	11036 01	40174 02	80761-02	99000 00
3500 04	46702 01	19033 00	40105 02	80761-03	99900 00
3500 04	46702 01	-36096 00	40098 02	80761-04	99990 00
3500 04	46702 01	-48932 00	40097 02	80761-05	99999 00
3259 04	99866 00	37461 01	48051 02	83447 00	-25029-08
3259 04	99866 00	37003 01	47116 02	75102 00	10000 00
3259 04	99866 00	36492 01	46217 02	66758 00	20000 00
3259 04	99866 00	35912 01	45352 02	58413 00	30000 00
3259 04	99866 00	35242 01	44519 02	50068 00	40000 00
3259 04	99866 00	34451 01	43715 02	41724 00	50000 00
3259 04	99866 00	33482 01	42940 02	33379 00	60000 00
3259 04	99866 00	32233 01	42192 02	25034 00	70000 00
3259 04	99866 00	30472 01	41470 02	16689 00	80000 00
3259 04	99866 00	27463 01	40772 02	83447-01	90000 00
3259 04	99866 00	17485 01	40164 02	83447-02	99000 00
3259 04	99866 00	76969 00	40104 02	83447-03	99900 00
3259 04	99866 00	-60995-01	40098 02	83447-04	99990 00
3259 04	99866 00	-43481 00	40097 02	83447-05	99999 00
3000 04	10000-07	12089 02	20048 02	20000 01	
3000 04	10000-06	11089 02	20054 02	19995 01	
3000 04	10000-05	10088 02	20105 02	19943 01	
3000 04	10000-04	90706 01	20925 02	19162 01	
3000 04	10000-03	79586 01	27078 02	14808 01	
3000 04	10000-02	68452 01	35158 02	11405 01	
3000 04	10000-01	57909 01	39846 02	10063 01	
3000 04	10000 00	47399 01	44808 02	89487 00	
3000 04	14625 00	45619 01	46156 02	86873 00	-10026-07
3000 04	14625 00	45162 01	45469 02	78186 00	10000 00
3000 04	14625 00	44650 01	44802 02	69498 00	20000 00
3000 04	14625 00	44070 01	44155 02	60811 00	30000 00
3000 04	14625 00	43401 01	43525 02	52124 00	40000 00
3000 04	14625 00	42609 01	42914 02	43436 00	50000 00
3000 04	14625 00	41640 01	42319 02	34749 00	60000 00
3000 04	14625 00	40390 01	41741 02	26062 00	70000 00
3000 04	14625 00	38630 01	41178 02	17375 00	80000 00
3000 04	14625 00	35619 01	40631 02	86873-01	90000 00
3000 04	14625 00	25623 01	40150 02	86873-02	99000 00
3000 04	14625 00	15656 01	40102 02	86873-03	99900 00
3000 04	14625 00	59753 00	40098 02	86873-04	99990 00
3000 04	14625 00	-16980 00	40097 02	86873-05	99999 00

Table 1--continued

Temperature, T (°K)	Pressure, P (atm)	Log Volume, v (cc/gm)	Molecular Weight, M	Moles of Gas, n	Moles of SiC
25C0 04	1CCCC-C7	120C8 02	20143 02	19906 01	
2500 04	1CC00-06	1C968 02	22064 02	18173 01	
25C0 04	1CCCC-05	98487 01	29063 02	13796 01	
2500 04	10C00-04	87606 01	3559R 02	11264 01	
25C0 04	1CC00-03	77160 01	39451 02	10164 01	
25C0 04	1CCC0-02	66864 01	42230 02	94950 00	
2500 04	12127-02	659R5 01	42636 02	94044 00	-14584-07
2500 04	12127-02	65527 01	42368 02	84640 00	10000 00
2500 04	12127-C2	65016 01	42103 02	75235 00	20000 00
25C0 04	12127-02	64436 01	41842 02	65831 00	30000 0U
2500 04	12127-02	63767 01	41583 02	56427 00	40000 00
2500 04	12127-02	62975 01	41328 02	47022 00	50000 00
25C0 04	12127-02	62C06 01	41076 02	37618 00	60000 00
25C0 04	12127-C2	60756 01	40827 C2	28213 00	70000 00
2500 04	12127-02	58995 01	40581 02	18809 00	80000 00
2500 04	12127-02	55985 01	40337 02	94044-01	90000 00
2500 04	12127-C2	45985 01	40121 02	94044-02	99000 00
2500 04	12127-C2	35985 01	40100 02	94044-03	99900 00
2500 04	12127-02	259R8 01	40097 02	94044-04	99990 00
2500 04	12127-02	16019 01	4CC97 02	94044-05	99999 00
2200 04	24596-04	82513 01	41150 02	97442 00	-10746-07
2200 04	24596-04	82055 01	41042 02	87698 00	10000 00
2200 04	24596-04	81544 01	40935 02	77954 00	20000 00
2200 04	24596-04	8C964 01	40828 02	68210 00	30000 00
2200 04	24596-04	8C295 01	40722 02	58465 00	40000 00
2200 04	24596-C4	79503 01	40617 02	48721 00	50000 00
2200 04	24596-04	78534 01	40512 02	38977 00	60000 0G
22C0 04	24596-C4	772R4 01	40407 02	29233 0C	70000 00
2200 04	24596-04	75523 01	40303 02	19488 00	80U00 00
2200 04	24596-04	72513 01	40200 02	97442-01	90000 00
2200 04	24596-04	62513 01	40107 02	97442-02	99000 00
2200 04	24596-04	52513 01	40098 02	97442-03	99900 00
2200 04	24596-04	42513 01	40097 02	97442-04	99990 00
22C0 04	24596-C4	32514 01	40097 02	97442-05	99999 00
2CC0 04	1CCC0-C7	11663 02	35623 C2	11256 01	
2CC0 04	1C0C0-06	1C623 02	39137 02	10245 01	
2C00 04	95826-06	96259 01	40526 02	98942 00	-16809-07
2000 04	95826-06	95802 01	40483 02	89048 00	10000 00
2CC0 04	95826-C6	9529C 01	40439 02	79153 00	20000 00
2C00 04	95826-06	9471C 01	40396 02	69259 00	30000 0U
20CC C4	95R26-C6	94041 01	40353 02	59365 00	40000 C0

Table 1--continued

Temperature, T (°K)	Pressure, P (atm)	Log Volume, v (cc/gm)	Molecular Weight, M	Moles of Gas, n	Moles of SiC
2CC0 04	95826-06	93249 01	40310 02	49471 00	50000 00
2000 04	95826-06	9228C 01	40268 02	39577 CO	60000 00
2003 04	95826-06	91030 01	40225 02	29683 00	70000 00
2000 04	95826-06	89270 01	40182 02	19788 00	80000 00
2000 04	95826-06	86259 01	40140 02	98942-01	90000 00
20C0 04	95826-C6	76259 01	40101 02	98942-02	99000 00
2000 04	95826-06	66259 01	40098 02	98942-03	99900 00
2C00 04	95826-C6	56259 01	40097 02	98942-04	99990 00
2000 04	95826-06	46259 01	40097 02	98942-05	99999 00
1700 04	17355-08	12303 02	40023 02	10019 01	55760-08
1700 04	17355-C8	12257 02	40030 02	90167 00	10000 00
1700 04	17355-08	12206 02	40038 02	80148 00	20000 00
1700 04	17355-08	12148 02	40045 02	70130 00	3C000 00
1700 04	17355-08	12081 02	40053 02	60111 00	40000 00
17C0 04	17355-08	12002 02	4C060 02	50093 00	50000 00
17C0 04	17355-08	11905 02	40067 02	40074 00	6C000 00
1700 04	17355-C8	11780 02	40075 02	30056 00	7C000 00
1700 04	17355-08	11604 02	40082 02	20037 00	8C000 00
1700 04	17355-08	11303 C2	40090 02	10018 00	9C000 00
1700 04	17355-08	103C3 02	40096 02	10019-01	9900C 00
1700 04	17355-C8	93028 01	40097 02	10019-02	99900 00
1700 04	17355-C8	83028 01	40097 02	10019-03	99990 00
1700 04	17355-08	73028 01	40097 02	10019-04	99999 00
1774 04	1C000-07	11560 02	40136 02	99928 00	
1882 04	1C00C-06	10583 02	40293 02	99531 00	
2002 04	10000-05	96079 01	40532 02	98928 C0	
2140 04	1CC00-04	86326 01	40932 02	97957 00	
2299 04	1CCC0-03	76569 01	41573 02	96440 00	
2483 04	1CCCC-C2	66804 C1	42538 C2	94259 00	
2698 04	1C000-01	57021 01	43959 02	91213 00	
2953 04	1CCCC C0	47234 01	45810 02	87529 00	
3259 04	1CCCC C1	37455 01	48053 02	83444 00	
3632 04	1CCCC 02	27716 01	50430 02	79510 00	
4C96 04	1C00C C3	18054 01	52611 C2	76215 00	
4678 04	1C000 04	84855 0C	54416 C2	73687 00	

Table 2

SUMMARY OF COMPUTED VALUES OF DENSITY, ENTHALPY, ENERGY, AND ENTROPY FOR SILICON CARBIDE AT VARIOUS TEMPERATURES AND PRESSURES

Temperature, T (°K)	Pressure, P (atm)	Density, d (gm/cc)	Enthalpy, h (cal/gm)	Energy, u (cal/gm)	Entropy, s (cal/deg-gm)
6CC0 04	1CCCC-C7	27224-12	15612 05	14722 05	60744 01
6CC0 04	1CCC0-C6	27841-11	15134 05	14264 05	56560 01
6C00 04	1C000-C5	31055-10	12956 05	12176 05	49737 01
6COC 04	1CCGC-C4	36096-09	10321 05	96500 04	42577 01
6C00 04	1C000-03	39035-08	90984 04	84780 04	38078 01
6CC0 04	1CCC0-C2	4C164-07	86766 04	8C737 04	35034 01
6C00 04	1C000-C1	40548-06	85393 04	79421 04	32504 01
6CC0 C4	1CCCC C0	40724-05	84865 04	78919 04	30129 01
6CC0 04	10CC0 C1	41299-04	83813 04	77949 04	27682 01
6CC0 04	1C0CC C2	46022-C3	76518 04	71256 04	24299 01
6C00 04	1CC00 03	65591-02	57415 04	53722 04	19390 01
6CC0 C4	1CCCG 04	9C077-01	46268 04	43579 04	16332 01
55C0 04	1CC00-C7	3C299-12	14996 05	14196 05	59661 01
5500 04	1C000-06	33618-11	12929 05	12209 05	52694 01
55C0 04	1C0C0-C5	39149-10	10263 05	96442 04	45058 01
55C0 04	1CCC0-C4	42486-09	89903 04	84203 04	40273 01
55C0 04	1CCC0-C3	43781-08	85487 04	79955 04	37126 01
5500 04	1C0C0-02	44219-07	84054 04	78577 04	34563 01
55CC 04	1CCCC-C1	44377-06	83571 04	78113 04	32187 01
55C0 04	1CC00 CC	44596-05	83149 04	77718 04	29830 01
55C0 04	1CC00 C1	46321-04	8C461 C4	75233 04	27096 01
55C0 04	1CC00 02	58414-03	65831 04	61685 04	22432 01
55C0 04	1CCCC C3	83680-02	49368 04	46474 04	17993 01
55C0 04	1C0C0 04	1C712 00	42284 04	40024 04	15640 01
5C00 04	1CCC0-C7	37780-12	12359 05	11718 05	54591 01
5CC0 04	1CC00-C6	43733-11	98647 04	93110 04	46869 01
5CC0 C4	1CCC0-C5	47019-10	87583 04	82432 04	42210 01
5CC0 04	1CCCC-04	48257-C9	83804 04	78786 04	39118 01
5C00 04	1C000-03	48671-08	82584 04	77608 04	36575 01
5C00 04	1C0CC-02	48811-07	82186 04	77224 04	34208 01
5CC0 04	1CC00-01	48925-06	81959 04	77010 04	31880 01
5CCC 04	1CCCC 0C	49654-C5	80885 04	76008 04	29397 01
5CC0 04	1C0C0 01	56317-04	72261 04	67961 04	25521 01
5CCC 04	1CCCC 02	8C015-C3	531C4 04	5C077 04	20009 01
5CC0 04	1CCC0 03	10468-C1	43477 04	41164 04	16873 01

Table 2--continued

Tempera-ture, T (°K)	Pressure, P (atm)	Density, d (gm/cc)	Enthalpy, h (cal/gm)	Energy, u (cal/gm)	Entropy, s (cal/deg-gm)
5CC0 04	1CCC0 04	12715 C0	38835 C4	36931 04	14983 01
5C00 04	30044 C4	40407 00	37654 04	35853 04	14340 01
5CC0 04	3C044 C4	44277 0C	34984 04	33341 04	13A06 01
5C00 04	3C044 04	48966 0C	32315 04	30830 04	13272 01
5CC0 04	3C044 C4	54767 CC	29t46 04	28318 04	12739 01
5C00 04	30044 04	62127 C0	26977 04	25806 04	12205 01
5CC0 04	3C044 C4	71773 CC	24308 04	23295 04	11671 01
.5000 04	3C044 04	84964 C0	21639 04	20783 04	11137 01
5C00 04	3C044 04	1C410 01	18970 04	18271 04	10603 01
5000 04	30044 04	13435 01	16301 04	15760 04	10070 01
5C00 04	3C044 04	18938 C1	13632 04	13248 04	95357 00
5C00 04	3C044 04	29998 01	11230 04	10987 04	90553 00
5CC0 04	3C044 04	31859 01	10990 04	10761 04	90073 0C
5C00 04	30044 04	32058 01	10966 04	10739 04	90025 00
5CC0 04	30044 04	32078 C1	10963 04	10737 04	90020 00
45C0 04	1CCC0-C7	5C335-12	91710 04	86899 04	47913 01
45C0 04	1CC0C-C6	52933-11	84268 04	79693 04	43868 01
4500 04	1C000-05	53853-10	81805 04	77308 04	41004 U1
4500 04	1CCC0-04	54154-C9	81016 04	76544 04	38535 01
45C0 04	1CCCC-C3	54255-C8	80760 04	76296 04	36192 01
45C0 04	1C00C-C2	54324-C7	80629 04	76171 04	33880 01
4500 04	1C000-01	54734-06	80077 04	75653 04	31492 01
4500 04	1C0C0 C0	58966-05	74787 04	70680 04	28097 01
4500 04	1CCCC C1	80601-C4	56045 04	53040 04	22097 01
45C0 04	1CC00 02	1C645-02	44298 04	42023 04	18163 01
4500 04	10000 03	13045-01	38867 04	37011 04	15903 01
4500 04	51832 03	75706-01	36445 04	34787 04	14726 01
45C0 04	51832 03	83898-C1	33708 04	32212 04	14117 01
4500 04	51832 03	94078-01	30971 04	29637 04	13509 01
45C0 04	51832 03	10707 00	28234 04	27062 04	12901 01
45C0 04	51832 03	12422 0C	25497 04	24487 04	12293 01
45C0 C4	51832 C3	14792 CC	22761 04	21912 04	11685 01
45C0 04	51832 C3	18280 C0	2C024 04	19337 04	11076 01
45C0 04	51832 03	23918 C0	17287 04	16762 04	10468 01
4500 04	51832 03	34588 C0	14550 04	14187 04	98601 00
45C0 U4	51832 C3	62444 C0	11813 04	11612 04	92519 00
4500 04	51832 03	22692 01	935C1 03	92948 03	87C45 U0
4500 04	51832 C3	3C805 01	91038 03	90630 03	86498 00
45C0 04	51832 C3	31948 01	90791 03	90399 03	86443 00
45C0 C4	51832 CJ	32067 C1	90767 03	90375 03	86438 00

Table 2--continued

Temperature, T (°K)	Pressure, P (atm)	Density, d (gm/cc)	Enthalpy, h (cal/gm)	Energy, u (cal/gm)	Entropy, s (cal/deg-gm)
4CCC C4	1CCCC-C7	6C3P5-12	80899 04	76889 04	45400 01
4C00 04	1CC00-06	6C859-11	79801 04	75822 04	42827 01
4C0G 04	1C0C0-05	61012-10	79452 04	75483 04	40453 01
4C00 04	1C000-C4	61063-09	79337 C4	75371 04	38140 01
4CC0 04	1CCC0-03	61112-08	79263 04	75301 04	35840 01
4C00 04	1C000-C?	61460-07	78847 04	74907 04	33459 01
4C00 04	1C000-01	65462-C6	74292 04	70592 04	30096 01
4CC0 04	1C000 CO	88130-05	55888 04	53140 04	23620 01
4CC0 C4	1C00C 01	11536-03	43838 04	41739 04	19242 01
4CC0 04	1C000 02	13727-02	38743 04	36978 04	16857 01
4C00 04	64751 02	1C304-01	35456 04	33934 04	15272 01
4C00 04	64751 02	11445-01	32645 C4	31274 04	14569 01
4CC0 04	64751 02	12869-01	29833 04	28615 04	13866 01
4C00 04	64751 02	14699-01	27022 04	25955 04	13163 01
4C00 04	64751 C2	17136-01	24210 04	23295 04	12460 01
4C00 04	64751 C2	2C542-01	21399 04	20636 04	11757 01
4CC0 C4	64751 02	25636-01	1P588 04	17976 04	11055 01
4C00 04	64751 02	34090-01	15776 04	15316 04	10352 01
4CC0 04	64751 C2	5C865-01	12965 04	12657 04	96489 00
4C00 04	64751 C2	1C014 CO	10153 04	99968 03	89460 00
4C00 04	64751 C2	78178 CO	76231 03	76031 03	83134 00
4C00 04	64751 C2	24482 01	73701 03	73637 03	82502 00
4CC0 04	64751 C2	31114 C1	73448 03	73397 03	82439 00
4C00 04	64751 C2	31981 01	73423 03	73373 03	82432 00
35C0 04	1CC0C-07	69742-12	78073 04	74601 04	44654 01
35C0 04	1CCC0-06	69788-11	77983 04	74512 04	42344 01
3500 04	1C000-05	69807-10	77949 04	74480 04	40052 01
35C0 C4	1C00C-04	69863-09	77887 04	74420 04	37753 01
3500 C4	1C00C-C3	70434-08	77291 04	73853 04	35308 01
35C0 C4	1C00C-C2	779C4-C7	70010 04	66902 04	31037 01
35CC 04	1C000-01	10713-05	51148 C4	48887 04	23887 01
35C0 04	1CCCC CO	13329-04	41812 04	39595 04	19903 01
35C0 04	1CC0C 01	15268-C3	37811 C4	36225 04	17639 01
35CC C4	467C2 C1	80736-C3	34944 04	33543 04	16162 01
35CC 04	46702 C1	897C4-03	32015 04	30754 04	15325 01
35C0 04	46702 01	10091-02	29085 04	27964 04	14488 01
35CC 04	46702 C1	11533-02	26155 04	25175 04	13651 01
35C0 04	467C2 C1	13454-02	23226 04	22385 04	12814 01
35C0 C4	467C2 C1	16143-02	2C296 04	19596 04	11977 01
35C0 04	46702 01	20176-C2	17367 04	16806 04	11140 01
35C0 C4	46702 C1	26896-02	14437 C4	14017 04	1C303 01

Table 2--continued

Temperature, T (°K)	Pressure, P (atm)	Density, d (gm/cc)	Enthalpy, h (cal/gm)	Energy, u (cal/gm)	Entropy, s (cal/deg-gm)
35C0 C4	467C2 C1	40328-02	11508 04	11227 04	94661 00
35C0 C4	467C2 C1	8C554-C2	85783 03	84379 03	86291 00
3500 04	46702 C1	78774-C1	59417 03	59274 03	78758 00
3500 04	46702 C1	64516 0C	56781 C3	56763 03	78004 0C
35C0 04	467C2 C1	22959 01	56517 03	56512 03	77929 00
35C0 04	467C2 C1	3C854 01	56491 03	56487 03	77922 C0
3259 04	99866 CC	17944-03	34937 04	33589 04	16788 01
3259 U4	99866 CC	19938-03	31927 04	30714 04	15864 01
3259 04	99866 CC	22430-03	28917 04	27839 04	14941 U1
3259 04	99866 CC	25634-03	25908 04	24964 04	14017 01
3259 C4	99866 CC	299C6-03	22898 04	22089 04	13094 01
3259 04	99866 CC	35887-03	19888 04	19214 04	12170 01
3259 04	99866 CC	44857-03	16879 04	16339 04	11247 01
3259 04	99866 CC	598C7-03	13869 04	13465 04	10323 01
3259 04	99866 CC	897C1-C3	10859 04	10590 04	93997 00
3259 04	99866 CC	17935-02	78495 03	77146 03	84762 00
3259 04	99866 0C	17845-01	51407 03	51272 03	76450 00
3259 04	99866 00	16995 00	48698 03	48684 03	75619 00
3259 04	99866 CC	115C8 C1	48428 03	48425 03	75536 00
3259 04	99866 CC	27215 01	48400 03	48400 03	75527 00
3000 04	1C000-07	81442-12	76611 04	73637 04	44204 01
30C0 04	1CC00-06	81463-11	76590 04	73618 04	41915 U1
3CC0 04	1CCC0-05	81674-1C	764C1 04	73436 04	39572 01
3000 04	1C000-04	85CC3-09	73411 04	7C562 04	36326 01
3000 04	1C000-03	110C0-07	56360 04	54158 04	26679 01
3C00 04	1C000-02	14242-06	43576 C4	41880 04	22947 01
3CC0 U4	1C000-01	16186-05	38942 04	37446 04	20190 01
3CC0 04	1CC0C CC	182C2-04	35808 04	34479 04	18053 U1
3C00 04	14625 C0	27421-04	35105 04	33814 04	17653 01
3C00 04	14625 C0	3C468-04	31992 04	30830 04	16615 01
3CC0 04	14625 CC	34277-04	28880 04	27846 04	15578 01
3C00 04	14625 C0	39173-04	25767 04	24862 04	14540 U1
3C00 04	14625 C0	45702-04	22654 04	21879 04	13502 01
3C00 04	14625 CC	54842-04	19541 04	18895 04	12465 01
3CC0 04	14625 CC	68552-C4	16428 04	15911 04	11427 C1
3C00 04	14625 0C	914C3-C4	13315 04	12927 04	10390 01
3C00 04	14625 C0	13710-03	10202 04	99436 03	93519 00
3C00 04	14625 0C	27419-03	7C890 03	69598 03	83142 00
3CC0 04	14625 CC	27398-C2	42873 C3	42744 03	73803 00
3CC0 04	14625 CC	27189-C1	4C072 03	4C059 C3	72870 C0
3CC0 C4	14625 0C	25262 0C	39791 C3	39790 03	72776 00
3CC0 C4	14625 CC	14784 01	39763 03	39763 03	72767 CC

Table 2--continued

Temperature, T (°K)	Pressure, P (atm)	Density, d (gm/cc)	Enthalpy, h (cal/gm)	Energy, u (cal/gm)	Entropy, s (cal/deg-gm)
2500 04	10000-07	98193-12	74942 04	72476 04	43588 01
2500 04	10000-06	10756-10	68100 04	65848 04	38639 01
2500 04	10000-05	14168-09	50870 04	49161 04	29935 01
2500 04	10000-04	17353-08	41610 04	40215 04	24817 01
2500 04	10000-03	19231-07	37863 04	36604 04	22106 01
2500 04	10000-02	20586-06	35925 04	34749 04	20205 01
2500 04	12127-02	25205-06	35679 04	34514 04	20017 01
2500 04	12127-02	28006-06	32344 04	31295 04	18682 01
2500 04	12127-02	31507-06	29008 04	28076 04	17348 01
2500 04	12127-02	36008-06	25673 04	24857 04	16014 01
2500 04	12127-02	42009-06	22337 04	21638 04	14680 01
2500 04	12127-02	50411-06	19002 04	18419 04	13346 01
2500 04	12127-02	63014-06	15667 04	15200 04	12011 01
2500 04	12127-02	84018-06	12331 04	11982 04	10677 01
2500 04	12127-02	12603-05	89957 03	87626 03	93431 00
2500 04	12127-02	25205-05	56602 03	55437 03	80090 00
2500 04	12127-02	25205-04	26583 03	26467 03	68082 00
2500 04	12127-02	25204-03	23581 03	23570 03	66881 00
2500 04	12127-02	25186-02	23281 03	23280 03	66761 00
2500 04	12127-02	25009-01	23251 03	23251 03	66749 00
2200 04	24596-04	56066-08	35828 04	34766 04	21931 01
2200 04	24596-04	62296-08	32380 04	31424 04	20364 01
2200 04	24596-04	70082-08	28932 04	28082 04	18797 01
2200 04	24596-04	80094-08	25484 04	24740 04	17229 01
2200 04	24596-04	93443-08	22036 04	21398 04	15662 01
2200 04	24596-04	11213-07	18588 04	18057 04	14095 01
2200 04	24596-04	14016-07	15140 04	14715 04	12528 01
2200 04	24596-04	18689-07	11692 04	11373 04	10960 01
2200 04	24596-04	28033-07	82436 03	80311 03	93929 00
2200 04	24596-04	56066-07	47955 03	46892 03	78256 00
2200 04	24596-04	56066-06	16922 03	16816 03	64150 00
2200 04	24596-04	56066-05	13819 03	13808 03	62740 00
2200 04	24596-04	56065-04	13509 03	13507 03	62599 00
2200 04	24596-04	56056-03	13477 03	13477 03	62585 00
2000 04	10000-07	21707-11	40186 04	39071 04	28036 01
2000 04	10000-06	23848-10	36819 04	35804 04	25136 01
2000 04	95826-06	23664-09	35733 04	34753 04	23466 01
2000 04	95826-06	26293-09	32230 04	31348 04	21715 01
2000 04	95826-06	29579-09	28727 04	27943 04	19963 01
2000 04	95826-06	33805-09	25224 04	24538 04	18212 01
2000 04	95826-06	39439-09	21721 04	21133 04	16460 01

Table 2--continued

| Temperature, T (°K)	Pressure, P (atm)	Density, d (gm/cc)	Enthalpy, h (cal/gm)	Energy, u (cal/gm)	Entropy, s (cal/deg-gm)
2CC0 04	95826-C6	47327-C9	18218 C4	17728 04	14709 01
2C00 04	95826-C6	59159-C9	14715 04	14323 04	12957 0X
2000 04	95826-C6	78878-C9	11212 04	10918 04	11206 01
2000 04	95826-06	11832-08	77091 03	75129 03	94541 00
2CC0 04	95826-C6	23664-08	42060 03	41080 03	77026 00
20C0 C4	95826-06	23664-07	1C533 03	10435 03	61262 00
2C00 04	95826-06	23664-06	738C0 02	73702 02	59686 00
2C00 04	95826-06	23663-05	70647 02	70637 02	59528 00
2C00 04	95826-06	23663-04	70332 02	70331 02	59512 U0
17C0 04	17355-08	49793-12	35338 04	34494 04	26369 01
1700 04	17355-08	55326-12	31779 04	31019 04	24275 01
1700 04	17355-C8	62241-12	28220 04	27545 04	22182 01
1700 04	17355-C8	71133-12	24661 04	24C70 04	20089 01
1700 04	17355-08	829P9-12	21102 04	20596 04	17995 01
17C0 04	17355-08	99586-12	17543 04	17121 04	15902 01
1700 04	17355-C8	12448-11	13985 04	13647 04	13808 01
17C0 04	17355-C8	16598-11	10426 04	10173 04	11715 01
17C0 04	17355-08	24897-11	68669 03	66981 03	96214 00
17C0 04	17355-C8	49793-11	33081 03	32237 03	7528C 0C
1700 04	17355-08	49793-10	10517 02	96727 01	56434 00
1700 04	17355-08	49793-C9	-21513 02	-21597 02	54555 00
1700 04	17355-C8	49793-08	-24716 02	-24724 02	54366 00
17C0 04	17355-08	49793-07	-25036 02	-25037 02	54348 U0
1774 04	1CCCC-C7	27569-11	35448 04	34570 04	25570 01
1882 04	1CCC0-06	26102-1C	35601 04	34674 04	24513 01
2C02 04	1CCC0-C5	24669-09	35735 04	34754 04	23446 01
2140 04	1CC0C-04	23303-08	35817 04	34778 04	22361 01
2299 04	1CC00-03	22034-07	35807 04	34709 04	21248 01
2483 04	1CC00-02	20875-06	35693 04	34533 04	20113 01
2698 04	1CCCC-C1	19854-05	35438 04	34219 04	18957 01
2953 04	1CCCC CC	18904-04	35149 04	33869 04	17832 01
3259 04	1C000 01	17968-03	34937 04	33588 04	16787 01
3632 04	1CCC0 02	16920-02	35019 04	33587 04	15880 01
4C96 04	1CCCC C3	15653-01	35620 04	34073 04	15148 01
4678 04	1CCCC C4	14173 CC	36859 04	35151 04	14575 01
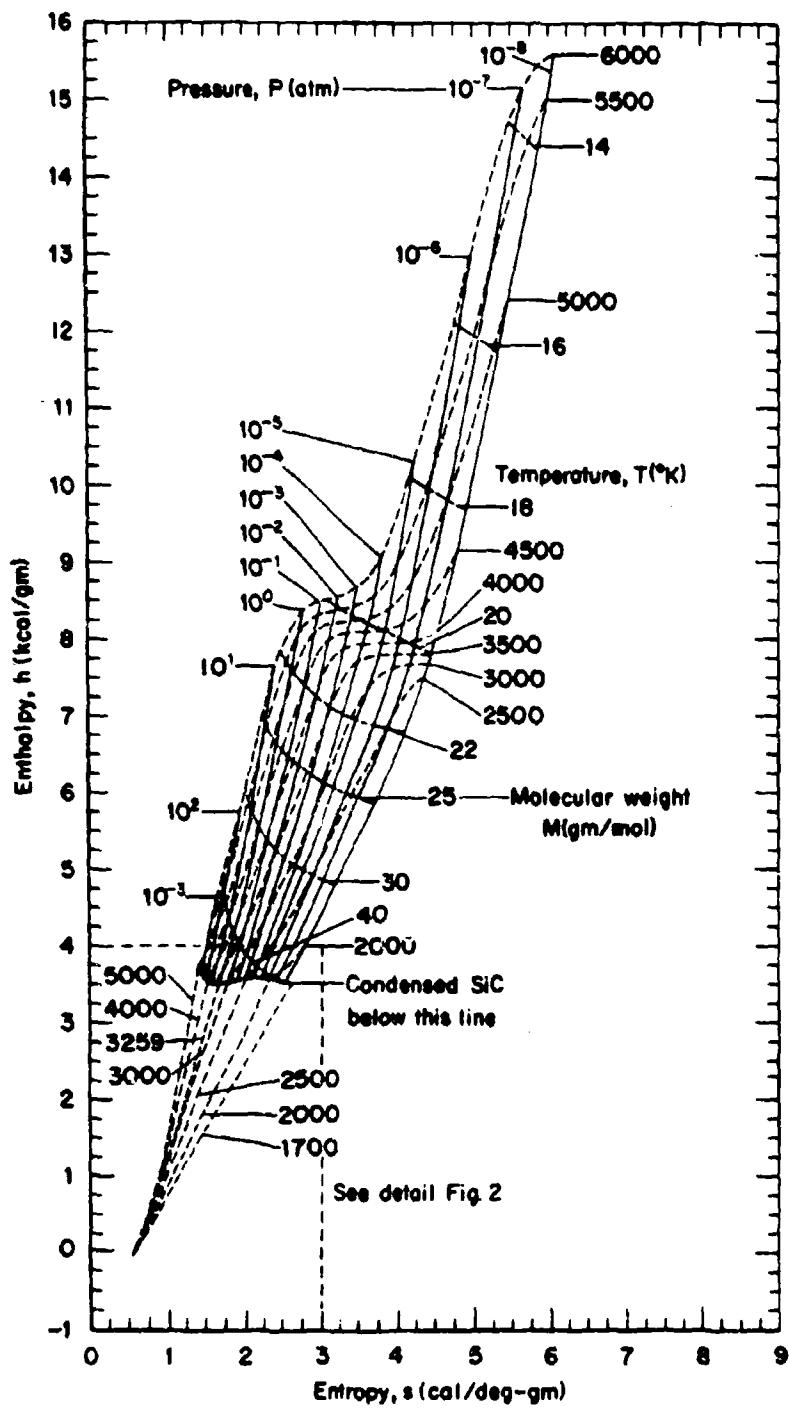
Fig. 1— Enthalpy versus entropy for silicon carbide with cross plots of
temperature, pressure, molecular weight, and moles of condensed SiC
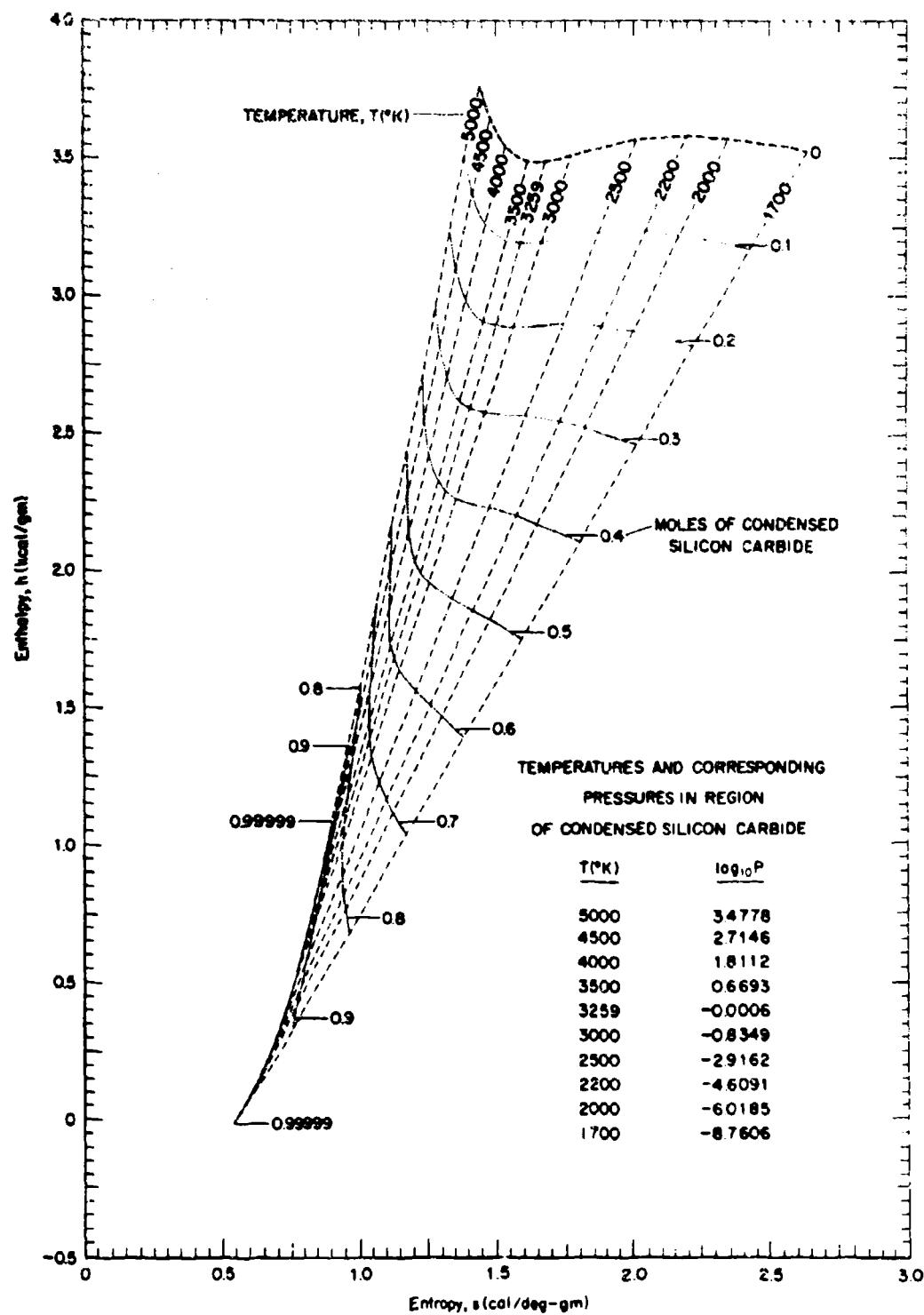
Fig. 2 --- Detail of Fig. 1 showing fine structure in area of condensed SiC
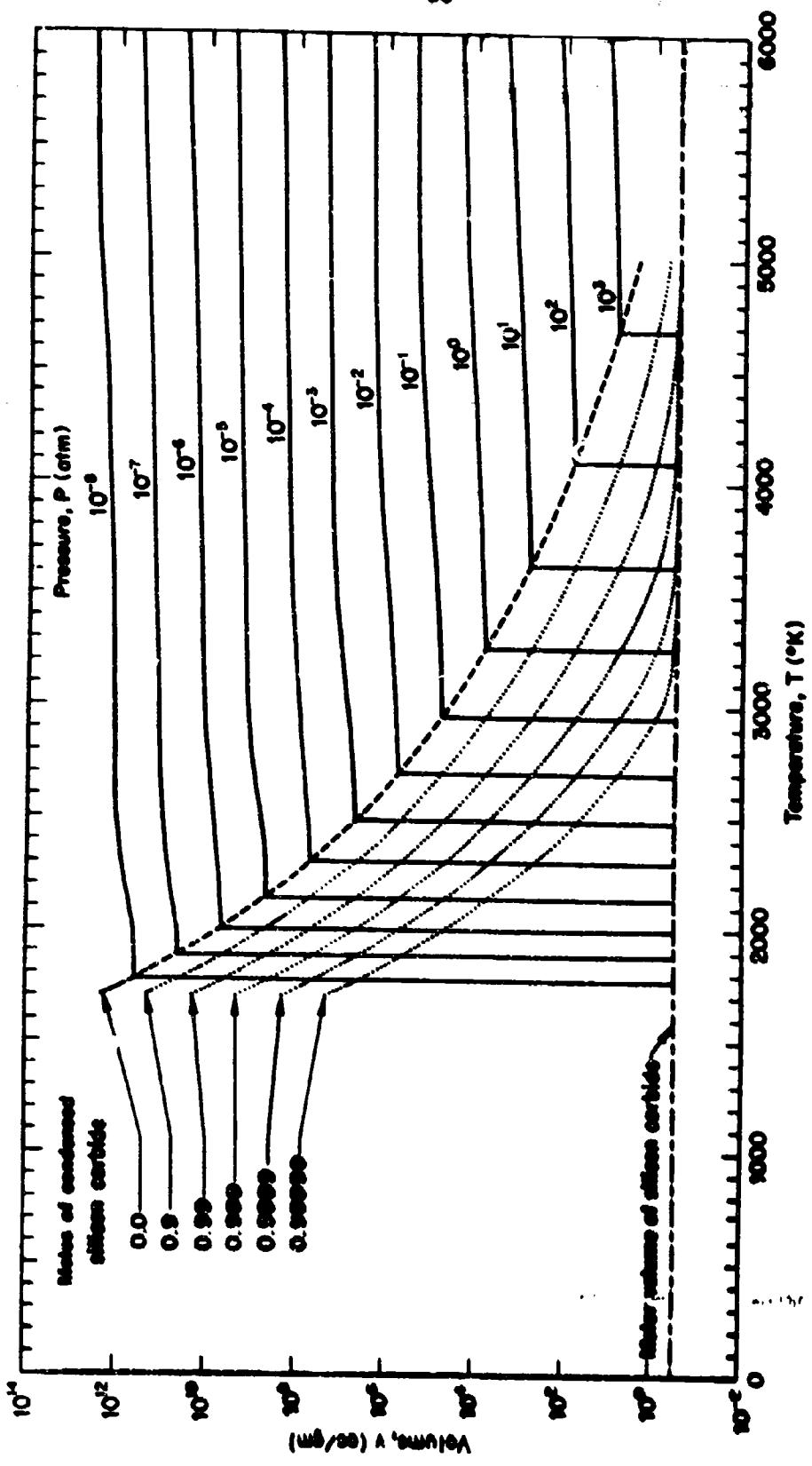
Fig. 3—Volume versus temperature for silicon carbide with cross plots of constant pressure and moles of condensed SiC
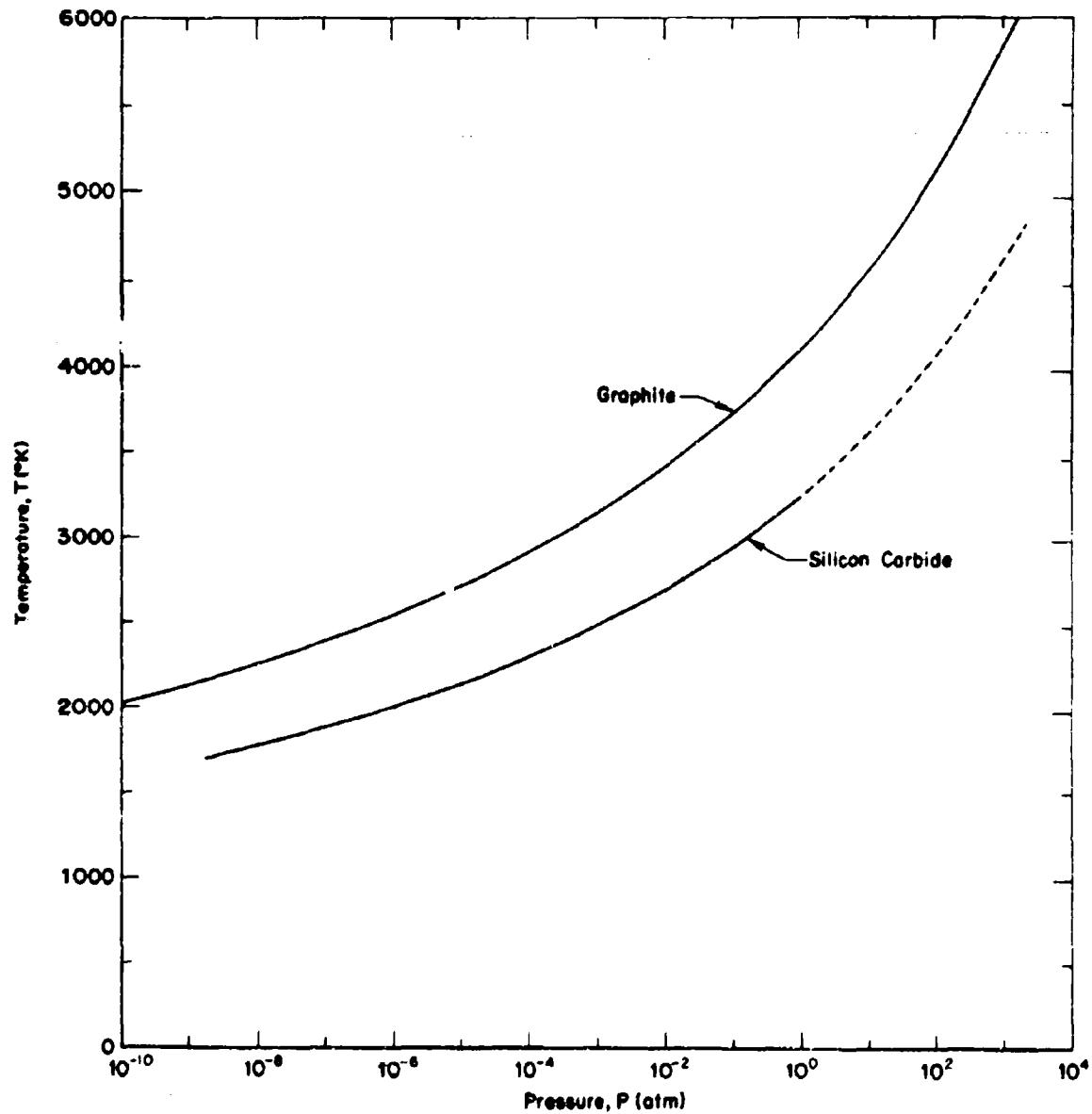
Fig. 4—Sublimation temperature for silicon carbide and graphite at various pressures

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DOCUMENT CONTROL DATA

I ORIGINATING ACTIVITY	2a. REPORT SECURITY CLASSIFICATION
THE RAND CORPORATION	UNCLASSIFIED
	2b. GROUP

3. REPORT TITLE
THE THERMODYNAMICS OF THE SILICON CARBIDE/SILICON-CARBON VAPOR SYSTEM

4. AUTHOR(S) (Last name, first name, initial)
Krieger, F. J.

5. REPORT DATE	6a. TOTAL No. OF PAGES	6b. No. OF REFS.
April 1968	40	5

7. CONTRACT OR GRANT No.	8. ORIGINATOR'S REPORT No.
F44620-67-C-0045	RM-5592-PR

9a. AVAILABILITY/LIMITATION NOTICES	9b. SPONSORING AGENCY
DDC-1	United States Air Force Project RAND

10. ABSTRACT	11. KEY WORDS
An investigation of the thermodynamic properties of silicon carbide (SiC) over a range of temperatures up to 6000°K and pressures up to 1000 atmospheres. Two sets of equilibrium composition equations are used--one representing a pure gas phase, the other a heterogeneous system of gas and condensed (solid) silicon carbide. The gas phase of the heterogeneous chemical system, like the homogeneous gas phase, comprises 25 gaseous silicon-carbide species. Tabulated summaries give computed values of volume, molecular weight, moles of gas, moles of solid SiC, density, enthalpy, energy, and entropy for silicon carbide at various temperatures and pressures. A conventional Mollier diagram is included in which specific enthalpy is plotted against specific entropy, with cross plots of temperature, pressure, and molecular weight in the pure gas region, and cross plots of temperature and moles of condensed SiC in the gas-solid region. Variation of sublimination temperature with pressure for silicon carbide and graphite is also shown.	Physics Chemistry Thermodynamics