Note

Specific Heat Capacity of Solids under Pressure from Measurements of \((\partial T/\partial P)_s\)

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A procedure is described for calculating specific heat capacity under pressure, \(c_p(T, P)\), from data for \(c_p(T, 0)\) and adiabatic \((\partial T/\partial P)_s\). The main advantage is that \((\partial T/\partial P)_s\) can be readily measured under high-pressure conditions.

KEY WORDS: adiabatic compression; calculational procedure; high pressure; specific heat capacity.

1. INTRODUCTION

Heat capacity under pressure is a difficult measurement, and there are so far relatively few results (see reviews by Bäckström [1] and Loriers-Susse [2]). On the other hand, there exist extensive results at effectively zero pressure for specific heat capacity at constant pressure as a function of temperature, \(c_p(T, 0)\) (see the compilation by Touloukian and Buyco [3]). The purpose of the present note is to describe how the relatively simple measurement of \((\partial T/\partial P)_s\) under pressure enables data for \(c_p(T, 0)\) to be extended to high-pressure conditions.

2. DESCRIPTION OF THE PROCEDURE

A method for measurement of the rate of change of temperature with pressure at constant entropy, \((\partial T/\partial P)_s\), has been described by Boehler et al.

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A solid specimen of the substance under investigation is arranged to have a thermocouple junction immersed in it at a central location. The specimen is then coated with an elastomer and placed in the pressure-transmitting medium in a pressure vessel. A sufficiently rapid change of pressure yields a $T, P$ trajectory which is effectively adiabatic. The temperature is measured using the thermocouple located within the specimen and the pressure is measured using a manganin resistance gauge located in the pressure-transmitting medium.

Figure 1 shows a $T, P$ projection which may be taken to refer to the central part of the specimen. It is assumed that $c_p(T, 0)$ is known from $T_{\text{min}}$ to $T_{\text{max}}$ and that the lines in Fig. 1 labeled $s_1, s_2, \ldots, s_n$ correspond to the results of adiabatic experiments of the type just described. It can be assumed that the specific entropy $s(T, 0)$ is also known, apart from a constant term, since

$$s(T, 0) = s(T_{\text{min}}, 0) + \int_{T_{\text{min}}}^{T} c_p(T', 0) \, d \ln T'$$

(1)

It follows that the entropies $s_1, s_2, \ldots, s_n$ of the adiabats are also known from the intercept of each adiabat with the axis $P = 0$. We now consider the

Fig. 1. $T, P$ projection for substance under investigation. $c_p(T, 0)$ is assumed to be known over the temperature range $T_{\text{min}}$ to $T_{\text{max}}$. Lines labeled $s_1, s_2, \ldots, s_n$ are from measurements of $(\partial T/\partial P)_S$. Dashed line indicates isobar at $P = P_1$. 