DEAT-BC 64-0125

te and shown in Fig. 2*b*. This yielded $\alpha = 75\ \text{cm}^{-1}$. uming then that α is directly proportional to concentration, the remaining theoretical curves, esponding to 2.6, 5.2, and 14.2 g/*l*, were com- ed using $\alpha = 150$, 300, and 820 cm^{-1}, respectively. he value of σ_1 may be computed using the con- nts of distilled water; for $E_0 = 0.05\ \text{J/cm}^2$, 3.7 atm.

here is good agreement between the time varia- and relative amplitudes of the experimental theoretical stress profiles shown in Figs. 2 3. Due to a large uncertainty in the experi- tal value of E_0, it is difficult to compare absolute litudes; however, there is at least order of itude agreement. Thus, these results appear confirm that transient heating is the source of coustic transients observed in this study.

he authors are indebted to P. E. Parks for his n calibrating the acoustic detector.

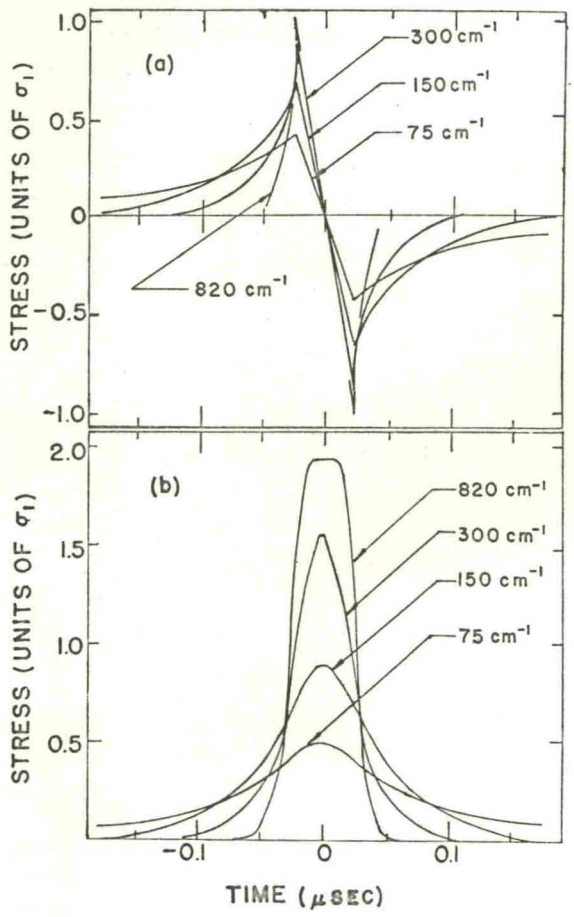

Fig. 3. Theoretical stress impulses produced by transient heating of samples having various optical absorptivities for (*a*) pressure-release boundary conditions, and (*b*) rigid boundary conditions, at the illuminated interface.

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amplitude of the stress impulse arising from the sum change of the laser beam would be about atm.

ELECTRICAL RESISTANCE OF BARIUM AT ELEVATED PRESSURE AND TEMPERATURE

phase transformations; to 67 kb; to 800°C; E)

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perimental results on the melting and poly- m of barium at elevated temperature and re were first reported in 1963, the measure- being made by differential thermal analysis.[2] ect data on the electrical resistance of barium mples at pressures to 67 kilobars (kb) and tures to 800°C. Bridgman has published data on room-temperature resistance discontinuities in Ba at 17 and 59 kb,[3,4] and more recently, Balchan and Drickamer[5] found a sharp discontinuity in resistance near 144 kb. Since it has been tentatively assumed that the room-temperature transition at 144 kb corresponds to melting,[2,6] it was felt that a study of the resistance upon melting at lower

pressures could definitely provide information on the validity of this assumption.. In fact, our resistance melting curves are quite similar to those of Stager and Drickamer[6] and our data thus lend evidence to the fact that Ba may be liquid at room temperature above 144 kb.

The measurements were made using a tetrahedral anvil device described previously.[7,8] The pyrophyllite sample tetrahedrons contained a graphite heater with stainless steel current leads, inside of which was placed a cylinder of pyrophyllite, boron nitride, or AgCl containing both the Ba sample and a chromel-alumel thermocouple. The Ba samples were extruded from commercial stock with a purity of 99+%. Copper or platinum wires were tied around the ends of the 380- to 750-μ Ba samples to provide resistance measurement leads. No correction was made for the effect of pressure on the emf of the chromel-alumel thermocouples. The thermocouple was positioned about 0.5 mm from the center of the Ba wire and was electrically insulated from it by the pyrophyllite, boron nitride, or AgCl. Temperatures are thought to be accurate to ±1.5%. Pressure calibration was made in the usual way[7,8] with Bi and Tl as well as Ba wires being placed in each of the sample cell configurations used. The pressure values are believed to be accurate to ±2.5% and no pressure correction due to the elevated temperature is assumed. All data were automatically recorded to facilitate analysis.

The data obtained on melting and on the BaI-BaII transition are shown in Fig. 1. The experimental points shown were taken directly from resistance-temperature curves (isobars) or resistance-pressure curves (isotherms) and the solid lines represent what we consider to be the best fit to the experimental points. The scatter in the data is thought to be caused by the pressure uncertainty. No data are shown below 20 kb because of equipment limitations at high temperatures in this pressure range. Our melting curve data agree quite closely with those of Jayaraman and others,[2] but the BaI-BaII transition line obtained in the present work has a pronounced negative slope in contrast with the positive slope found by differential thermal analysis (see Fig. 1). Repeated attempts failed to show any resistance discontinuities corresponding to the positive sloping phase line reported, and it seems unlikely that the transition would not show up as a resistance discontinuity at elevated temperatures. The transitions indicated by resistance measurements were sharper at high temperatures and were much less sluggish than the room temperature BaI-BaII transition. The triple point observed in the present work is found to occur at about 35 kb, 700°C, approximately where the fusion curve of Jayaraman and others[2] shows a slight break in slope. Recent high-pressure x-ray studies by Barnett, Bennion, and Hall[9] indicate that the Ba bcc structure changes to hcp structure at 59 kb, *i. e.*, at the BaI-BaII transition. No evidence of the 17-kb resistance transition reported by Bridgman[3] was observed in the present work.

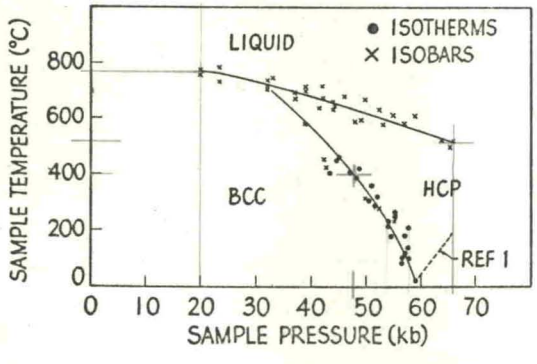

Fig. 1. Phase diagram of barium as determined by high-pressure, high-temperature resistance measurements. The dashed line is the data of Jayaraman and others obtained from differential thermal analysis.

If, indeed, our negative sloping curve is the BaI-BaII transition line, then an important conclusion is that the fusion curve determined above about 35 kb is that of BaII. The fusion curve has a negative slope that continues to the highest pressures achievable in our apparatus and if extrapolated to higher pressures would cross the room-temperature line in the vicinity of 140 kb. It is thus quite possible that the resistance transition near 144 kb and 25°C corresponds to melting.

Resistance vs temperature curves for the various phases of Ba are shown in Fig. 2. The transitions corresponding to melting and the BaI-BaII transformation are indicated. The melting transition shows a definite subcooling and sluggishness on decreasing the temperature as was observed also by Stager and Drickamer[6] in their resistance-temperature curve at 440 kb. The BaI and BaII phases show definite metallic behavior, each having a positive temperature coefficient of resistance. Our measurements of the resistance of the liquid phase are very rough, but indicate a very small positive temperature coefficient of resistance for the liquid. The similarity between the resistance

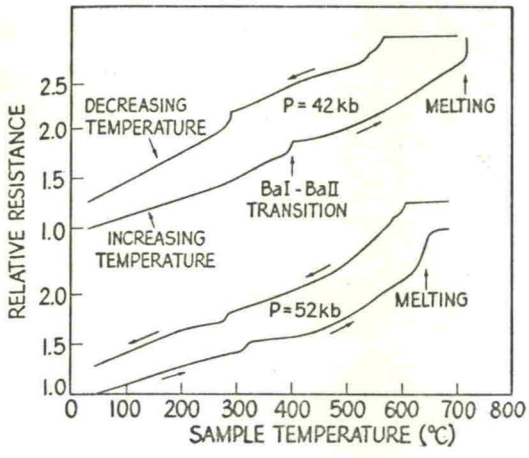

Fig. 2. Resistance vs temperature curves for the various phases of barium.

lting curves observed at low pressures in the pre- nt work and those obtained at higher pressures[6] d support to the tentative conclusion that the -kb transition at 25°C is indicative of melting. sitive identification of this phase as liquid, wever, can be made only after high pressure x-ray measurements are carried out. If Ba is liquid above 140 kb at low temperatures, the technological implications would be significant since true hydrostatic measurements would be possible in the very high pressure range at reasonable temperatures.

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IRECT OBSERVATION OF DISAPPEARANCE AND COLLAPSE OF STACKING-FAULT ETRAHEDRA IN GOLD FOILS DURING ION BOMBARDMENT IN THE ELECTRON MICROSCOPE

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(low to room temperature; E)

lcox and Hirsch[1] found that defects in the form stacking-fault tetrahedra were produced during nching and subsequent aging of gold. Cotterill others[2,3] bombarded quenched and aged Au at 20°C with 1.0- and 3.5-MeV alpha particles upon examining their foils in the electron micro- e after the bombardment found that the tetrahedra collapsed. They suggested that the interstitials rated during irradiation migrate to the tetrahedra cause them to collapse. To obtain further mation on the mechanism of collapse of the hedra and, hopefully, on the temperature of ion of interstitial atoms, we have been bom- g Au foils in the electron microscope with eV O^- ions emanating from coated emission filaments. In order to study this ion damage at low temperatures as well as at room temperature, a liquid helium cooled finger was constructed for the microscope. A sample temperature below 30°K (but above 15°K) could be attained, as determined by condensing xenon, krypton, argon, or nitrogen onto the cold sample during observation. Full details of the cold finger including the determination of specimen temperatures and the results obtained during ion bombardment of annealed copper below 30°K are given elsewhere.[4,5]

Stacking-fault tetrahedra were produced in 99.999% pure Au foil by quenching from 950°C into brine at 0°C and then aging for one hour at 100°C. When a normal emission filament was used in the electron