Transition in Properties of Indium at 170 K

ALTHOUGH indium twins readily at 293 K^{1,2} and 188 K², it seldom twins at 93 K¹. Experiments carried out at 93 K have shown that the microstructure shown by electron microscopy is characterized by areas of recrystallized regions, as shown in Fig. 1. Several grains were relatively free of dislocations. Differences such as ease of twinning up to 188 K and the relative absence of twinning at 93 K may be associated with a transition in certain basic deformation/physical properties of indium at a temperature between 188 and 93 K. Apart from electron microscope observations, results from dilatometric experiments suggest a discontinuity in the temperature-dilation trace.

A standard dilatometric set up was used with liquid nitrogen as the cooling medium. Cooling and heating runs were carried out over the range 293 K to 77 K. Specimens were very slowly lowered into and raised from the liquid nitrogen dewar during the cooling and heating runs respectively, which were repeated several times, using the same specimen as well as with different specimens. The averages of temperatures corresponding to small but distinct and reproducible changes in slope in the temperature-dilation curves were 166 K, during both cooling and heating.

If one considers the above observations from electron micro-

scopy and dilatometry in the light of the data in Table 1, it would seem that a transition in several physical properties of indium is strongly indicated at around 170 K. The nature and origin of this apparent transition, though not clear at present, could well form the basis of future studies.

Table 1 Summary of Observations Suggesting a Transition in Properties of Indium at 170 K

1. Stewart ³	Extrusion experiments	Shear sensitive transition suspected at very low temperature
2. Swenson ⁴	Compression experiments	Apparent discontinuity at 160 K
3. de Morton ⁵	Internal friction experiments	Damping peak and shear modulus relaxation at ~173 K
4. Gladkikh <i>et al.</i> ⁶	Tensile experiments	Discontinuities in elongation, reduction in area and ultimate tensile strength at ~173 K
5. Remaut <i>et al.</i> ² Dasarathy ¹	Observations on twinning	Twins readily at 293 and 188 K. Seldom twins at 93 K. Hence, a transition between 188 and 93 K inferred
6. Dasarathy	Dilatometry	Discontinuity in temperature-dilation trace at ~170 K
7. Chandrasekhar and Rayne ⁷	Elastic constants	Shear constants such as C_{11} in the range 1. 4–300 K found to have an unusually strong temp. dependence. $C_{11} = (C_{11} + C_{33} - 2C_{13})/4$. An apparent change in slope in $C_{33}/\text{temp.}$ at 161 K

This work is based on a private extension of research on indium and its alloys, originally initiated under the late Professor W. Hume-Rothery.

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Received November 10, 1971; revised August 4, 1972.

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Fig. 1 Typical microstructures of indium at 93 K, showing areas of recrystallization. *a*, Low magnification view, showing one heavily dislocated area, and a number of dislocation-free grains. *b*, Higher magnification view of dislocations at grain boundaries.

Shear Modulus of Liquids at Elastohydrodynamic Lubrication Pressures

A KNOWLEDGE of the limiting high-frequency shear modulus, G_{∞} , of liquids as a function of temperature and pressure is valuable for a number of reasons. First, the shear modulus is predictable from liquid-state theory which can therefore be checked against an experimental result. Second, the shear modulus is equally important with the viscosity in the description of the viscoelastic properties of a liquid. Third, in a special application of viscoelastic theory, the behaviour of an elastohydrodynamically lubricated (e.h.l.) contact can be calculated when the viscosity and shear modulus of the lubricant are known. We report here measurements made on di(2-ethyl-hexyl) phthalate, which is representative of synthetic lubricants. We believe it is the first report of the combined pressure and temperature variation of G_{∞} .