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Microdeformation of Solids

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Small-scale indentation experiments performed on nonmetallic specimens are reported. These experiments are very similar to others performed by one of us (N.G.) on metal specimens and reported in a previous issue of this journal. Again, it is believed that the theoretical strength of the perfect lattice is being observed.

In a previous paper[1] Gane and Bowden have reported the results of very small-scale indentation tests performed on electropolished single-crystal specimens of several fcc metals. These experiments were performed inside a scanning electron microscope, and used fine single-crystal titanium carbide tips, similar to field-ion microscope tips, as indenters. These tips were prepared by a two-layer ac electropolishing technique, developed originally by Ralph.[2] The results of these experiments were notable because (a) no deformation occurred until a critical load on the indenter was reached, and (b) this critical load was often very high, so that the shear stress corresponding to the onset of deformation approached the estimated theoretical shear strength.[3,4]

The purpose of the present communication is to report that similar results have been obtained from an analogous series of experiments performed on single crystals of two nonmetallic materials, germanium and magnesium oxide. {100} surfaces of magnesium oxide crystals and {111} surfaces of germanium crystals were prepared by chemical polishing and etching,[3] and the former were coated with a thin (~300 Å) layer of gold by vapor deposition, in order to prevent their being charged up by the incident electron beam when imaged in the scanning electron microscope. Germanium had sufficient conductivity that no such conducting layer was necessary. Figure 1 shows an indenter resting at zero load on a typical germanium specimen.

The principal experimental difference between the present work and that of Gane and Bowden[1] was that the tips used as indenters in the current experiments were those having the most nearly spherical ends. Tip radii were typically 2000–5000 Å, and were measured

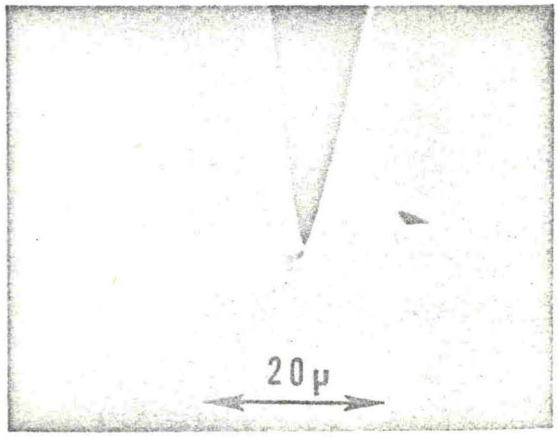

FIG. 1. A titanium carbide tip resting at zero load on a {111} germanium surface. Note the dislocation etch pit.