Letters

Influence of hydrostatic pressure on the microstructure of LiF single crystals containing cavities

When a solid containing elastic discontinuities is subjected to an external hydrostatic pressure, local shear stresses may be induced in the vicinity of these interfaces or boundaries [1]. Changes in microstructure and accompanying effects on the mechanical properties have been reported in cubic-metal and ionic crystals containing precipitate particles or grain boundaries [1-6] following pressurization in the range 3 to 30 kbar. It is generally accepted that dislocations are generated when locally the shear stress attains the value of the theoretical shear strength of the matrix. The purpose of this communication is to report generation of dislocations by hydrostatic pressure in LiF containing cavities.

Specimens of approximate dimensions 2 × 2 × 10 mm were cleaved along {100} planes from nominally pure single crystal LiF. To produce the cavities samples were irradiated to an integrated neutron flux of 5 or 8 × 10^{16} nvt, annealed for 20 h at 800°C and furnace cooled. Examination of the as-cooled material revealed the presence of small rectangular voids, described in detail by, e.g. Gilman and Johnston [7]. The cavities, whose sides were composed of {100} planes, displayed a wide variation in aspect ratio; dimensions of their sides being approximately in the range 10^{-1} to 10^{2} μm. Etching of the {100} faces in H_2O_2 showed that the majority of the voids were associated with low angle boundaries; the cavities within the subgrains, however, were completely dislocation free. The mean dislocation density in the as-cooled state was approximately 2 × 10^5 cm^{-2}.

Examination of etched {100} faces following pressurization treatments in the range 1 to 15 kbar revealed well-defined dislocation arrays surrounding the voids. Fig. 1 shows typical plastic regions in the vicinity of two cavities after pressurization at 3.5 kbar. Preliminary chemical polishing and etching experiments have shown these regions to consist of dislocation loops emanating from the cavity edges on six pairs of {110} slip planes; the spacing between pairs being determined by the orthogonal cavity diagonal. When viewed in a

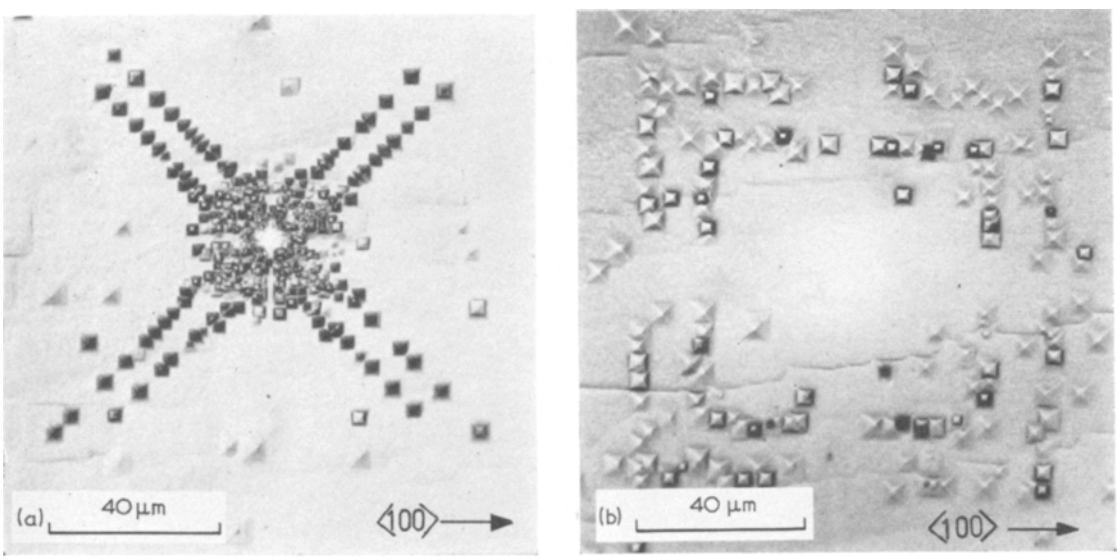
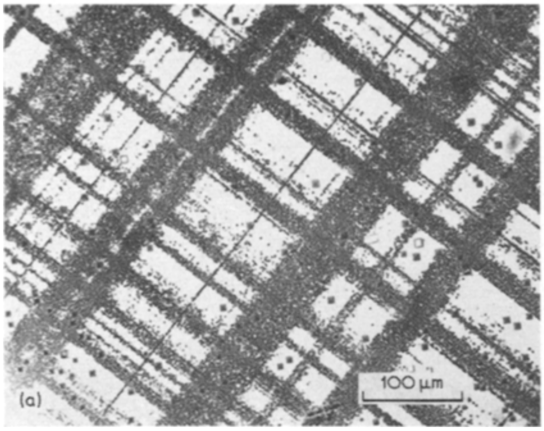


Figure 1 Well-defined dislocation arrays on ⟨110⟩ {110} about approximately cubical cavities in a LiF single crystal pressurized at 3.5 kbar. The cavities, face diagonals approximately 10 μm, were situated 10 and 40 μm below the surface in (a) and (b) respectively. Note that (a) and (b) respectively illustrate, principally the edge and screw components of the arrays.



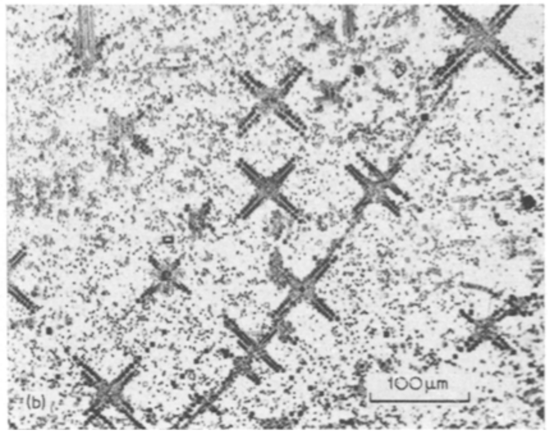


Figure 2 Comparison of the dislocation activity following 0.6% compressive strain in single crystal LiF irradiated and annealed to produce voids: (a) etched before and after straining and (b) etched before and after pressurization at 3.5 kbar and after straining.

⟨100⟩ direction, the arrays appear symmetrical about the cavity. There is a size dependant threshold pressure, below which no plastic activity is detectable, and above this threshold the extent of resultant arrays varies with pressure.

Preliminary compression testing of irradiated and annealed material, both unpressurized and pressurized, indicates that the pressure-induced dislocations suppress stage I [8] of the stress-strain curve and raise the flow stress and work-hardening rate. Etching of strained crystals has shown that pressurization inhibits the formation of well-defined slip bands characteristic of stage I (Fig. 2).

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R. A. EVANS
B. A. W. REDFERN
A. S. WRONSKI
School of Materials Science
University of Bradford
Yorks, England

The failure of polycrystalline chromium between 657 and 706 K

Controversy continues concerning the relative importance of crack nucleation and crack propagation in the fracture of body-centred cubic transition metals. In chromium in particular, some investigators have postulated that the critical event is always crack nucleation [1, 2] i.e. that the first crack to be nucleated propagates. Thus, it has been suggested [2] that the fracture of polycrystals deformed plastically in