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Hydrostatic Pressure and Plastic Deformation of the Alkali Halides

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The effect of hydrostatic pressure on the plastic deformation of metal single crystals is not very important (1): a small rise in flow stress can be interpreted in terms of the work done against pressure to produce the volume increase associated with plastic deformation. This volume increase is due to anharmonic effects in the long range elastic field of dislocations, the core effects being negligible (2). On the other hand alkali halides show a marked dependence of flow stress on hydrostatic pressure (3, 4). The purpose of this note is to show that in ionic solids the presence of dislocations with dissociated cores on (110) planes (5) is compatible with the observed pressure effect.

In alkali halides the stacking fault energy $\gamma(x)$ for a $(x/\sqrt{2})$ $[110]$ $(1\bar{1}0)$ fault is quite well approximated by (5)

$$\gamma(x) = \gamma_o \sin^2(\pi x/b),$$

where b is the absolute value of the perfect Burgers vector of the structure and γ_o the energy of a b/2 Burgers vector fault. Faulting introduces a strong dilatation ε between the two planes adjacent to the stacking fault. ε is a maximum for the b/2 fault being then equal to ε_o ($\varepsilon = \delta d_{(1\bar{1}0)}/d_{(1\bar{1}0)}$ with $d_{(1\bar{1}0)} = b/2$). Taking into account electronic polarization of the ions in the neighbourhood of the fault, computed values are $\gamma_o = 330$ ergcm^{-2}, $\varepsilon_o = 0.27$ for lithium fluoride, and $\gamma_o =$ = 195 ergcm^{-2}, $\varepsilon_o = 0.32$ for sodium chloride. $\gamma(x)$ has no minimum in the range $0 < x < b$. Thus the stacking fault cannot extend all through the crystal on a (110) plane since it is not even a metastable defect. It is possible, however, to speak of a dissociated core of a dislocation, the repulsion between partial dislocations stabilizing the stacking fault. Since there is no local minimum in $\gamma(x)$ one considers a continuous distribution of partial dislocations of a density $\rho(x)$. In a more

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