should exhibit large yield drops (figs. 4 and 5) (Johnston and Gilman 1959, Hahn 1962). Thus, the introduction of free dislocations by pressurization should reduce the magnitude of the yield drop, as observed. No doubt the yield point could be completely removed if the pressure were increased or the size distribution of Cr_2O_3 particles were coarsened.

The similarity of the tensile load/elongation curves (figs. 4 and 5) after pressurization for the 'single-slip' and 'multiple-slip' orientations indicates that both deform by multiple slip, probably due to the introduction of free dislocations on secondary slip systems. The situation appears analogous to that of dispersion-hardened f.c.c. crystals which has been treated by the secondary slip theory (Ashby 1966). Here the plastic zones around particles propagate as straining proceeds and the number of forest dislocations, which must be cut by gliding primary dislocations, increases. The observation that ageing after pressurization restores the load/elongation relationship to that of as-grown crystals (fig. 5) shows that the propagation and multiplication of dislocations from pressure-induced sources causes the increased forest density responsible for the hardening; the pressure-induced dislocations locked *in situ* by the ageing do not themselves measurably increase the hardening. The forest density necessary to account for the increased hardening of the crystal in fig. 4, according to the secondary slip theory, is about $4 \times 10^{11}\,\mathrm{cm}^{-2}$ at 3% elongation.

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APPENDIX

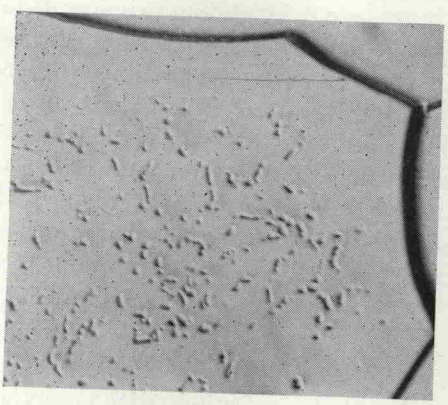
The Production of Etch-pits at Dislocation Sites in Chromium

The direct observation of the extremely inhomogenous low-density distributions of dislocations resulting from pressurization is more readily accomplished by surface etch-pitting than by transmission electron microscopy. This Appendix outlines two methods for producing dislocation etch-pits in chromium and contrasts their different etching characteristics and, thus, their suitability for application to the present study.

Reid *et al.* (1967) produced dislocation etch-pits by electro-etching in a saturated ($\sim 10\%$) solution of oxalic acid at 10 volts closed circuit for about 15 sec ; a typical result (fig. 9) shows that the features are etch-hillocks *above* the surface and not pits. The optimum surface orientation is {111}, leading to triangular shapes. Dislocations nearly parallel and close to the surface produced raised linear traces. This method only reveals dislocation structures typical of as-grown or recrystallized chromium. Dislocations introduced at ambient temperature (e.g. by a scratch) did

not etch after ageing at either low or high temperatures, even after treatment above 1000° C just below recrystallization. Apparently the etching response depends on the difference in chemical reactivity due to a high degree of segregation. Hillock-free zones near grain boundaries also suggest that heavy segregation of non-metallics on dislocations (Garrod and Wain 1965) is necessary for etching. Single hillocks may thus mark homogeneously nucleated precipitates as well as dislocations. The high ageing temperatures to induce etching make this technique unsuitable to study pressurization since these dislocations run back to the particle/matrix interface at high temperatures (Besag and Bullen 1965).

Fig. 9



Etch-pits on a (111) surface of 'as recrystallized' chromium, produced by etching in 10% oxalic acid solution. Magn. × 1000.

A technique was developed using a procedure similar to that for etch-pitting 'fresh' dislocations in molybdenum (Prekel and Lawley 1966). Several solutions were tried on {100} surfaces. Chromium only responded to dilute oxalic acid and a 2% solution produced small, circular, shallow pits near surface scratches (fig. 10) after electro-etching for 15 sec at 10 volts ; similar etch-pits were produced at hardness indentations. Prolonged etching increased the diameter, but not the depth, of the pits. An observed loss of definition of the pits as the surface deviates from {100} is probably a geometrical effect due to their small depth.

The ability to etch-pit dislocations by this technique is lost after low-temperature ageing (400° C for 1 hr). This loss of etching response at dislocation sites probably results because an impurity atmosphere favours the reduction of reactivity locally, as shown by the etch-*hillocks* produced by the method of Reid *et al.*, and thus balances the tendency to *pit* due to the dislocation strain field. The segregated impurity seems unlikely to modify the dislocation strain field sufficiently to reduce the reactivity directly.