Equation (13b) may now be re-written thus

$$p_c = a\sigma_{00}e^{-\chi T} - \left\{\frac{16G\gamma'}{\pi(1 - \nu)k_0 e^{-\epsilon T}} - ak_0 e^{-\epsilon T}\right\} d^{-\frac{1}{2}}.$$

Eliminating constants, this becomes

$$p_c = \xi e^{-\chi T} - \left(\zeta e^{\epsilon T} - \lambda e^{-\epsilon T}\right) d^{-\frac{1}{2}} \qquad (17)$$

where $\xi = a\sigma_{00}$, $\zeta = \dfrac{16G\gamma'}{\pi(1 - \nu)k_0}$ and $\lambda = ak_0$.

Expanding equation (17) and ignoring second order terms (χ and ϵ are both small), we get

$$p_c = \xi(1 - \chi T) - \{\zeta(1 + \epsilon T) - \lambda(1 - \epsilon T)\}d^{-\frac{1}{2}}$$

or

$$p_c = \xi - (\zeta - \lambda)d^{-\frac{1}{2}} - \xi\chi T - \epsilon(\zeta + \lambda)d^{-\frac{1}{2}}T. \qquad (18)$$

For constant grain size, this reduces to Pugh's[3] equation (2) with

$$A' = \frac{\xi - (\zeta - \lambda)d^{-\frac{1}{2}}}{\xi\chi + \epsilon(\zeta + \lambda)d^{-\frac{1}{2}}}$$

$$B' = \frac{1}{\xi\chi + \epsilon(\zeta + \lambda)d^{-\frac{1}{2}}}$$

5. CONCLUSIONS

A theory for the brittle-ductile transition pressure has been developed and applied to the transition in zinc. It is shown that the quantities involved are of the right order. The theory predicts that the transition pressure increases both with σ_0 the frictional stress opposing the motion of a free dislocation (which may be increased by strain or quench-ageing and irradiation damage) and with increasing grain size.

The effect of temperature on the transition pressure is shown to be consistent with the empirical relationships of Pugh[1,3] and Galli and Gibbs[2].

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LIST OF FIGURES

1. The formation of a crack.