

The existence of a constant stress, σ_c , at the transition enabled us to carry out an analysis of the dependence of T_r on the strain rate, $\dot{\epsilon}$. Let us, as WROXSKI *et al.*⁴ have done for molybdenum, assume relationships between stress and temperature² and strain rate⁸, respectively, of the form:

$$\sigma_y = A - B\dot{\epsilon}$$

and

$$\sigma_x = E\dot{\epsilon}^n$$

(2)

where A and B are constant at a given strain rate and E and F are constant at a given temperature. B is approximately equal to $0.3 \text{ kg mm}^{-2} \text{ K}^{-1}$ for our material at all strain rates in the transition region and E and F have been evaluated for sintered tungsten at 473°K to be $\sim 68 \text{ kg mm}^{-2}$ and ~ 0.09 , respectively⁸. If we also

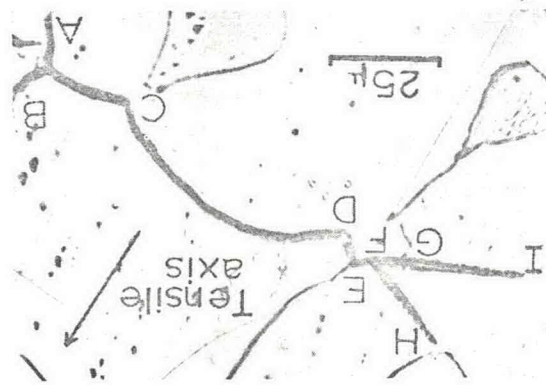


Fig. 2. Non-propagating surface crack in a recrystallized sintered tungsten specimen which cleaved at 442°K at a strain rate of $5 \times 10^{-3} \text{ sec}^{-1}$ after 0.6% plastic deformation. Note that the crack follows grain boundaries along AB, AC, CDEF, EH, FG and is transgranular only along the segment GI. (In order to avoid etch-pitting, Mirakami's reagent, which is a relatively poor etchant for tungsten, was employed.)

assume that (in the transition region) F is a constant, that the variation of E with temperature is given by eqn. (1), and make use of the identity:

$$\left(\frac{\partial \sigma}{\partial \dot{\epsilon}}\right)^n \left(\frac{\partial \sigma}{\partial T}\right) \dot{\epsilon} \left(\frac{\partial T}{\partial \dot{\epsilon}}\right)^{\sigma} = -1 \quad (3)$$

we derive for the relationship between T and $\dot{\epsilon}$, for constant σ the expression:

$$\exp(-\dot{\epsilon}^{0.09}) = K(E_0 - 0.3T)^n \quad (4)$$

where K and E_0 are constants. Figure 1 shows T_r plotted against $\exp(-\dot{\epsilon}^{0.09})$ and it is seen that, although not as good for molybdenum⁴, there is a fair agreement between the data and the model.

The constant stress at the transition temperature suggests that this is a critical stress for some mechanism in the fracture process. It appears that the transition coincides with a change in the critical stage in this process, a hypothesis supported by the observation of microcracks in ductile but not in brittle specimens. If the cracks observed in the ductile region are of the type that cause fracture, crack

irreversible changes in 5 strain rates and after irreversibly the tungsten. Hereafter no recrystallized specimens sintered (American) to reveal any effect. Cracks, away from the predominantly intercracks, appeared to be from $\sim 20 \mu$ to $\sim 150 \mu$ from ductile to brittle mm^{-2} for strain rates $\sim 377^\circ$ to $\sim 405^\circ\text{K}$.

rates of about 10³, other than during a test. increase in ductility transition metals were definitely ductile" wing a yield point eld stress. For tests rience in deciding e" or brittle. There eory. As we have stic deformation is fig. 1, are the upper stress were 53, 57, 10⁻⁴, 10⁻³, 2 x 10⁻³.