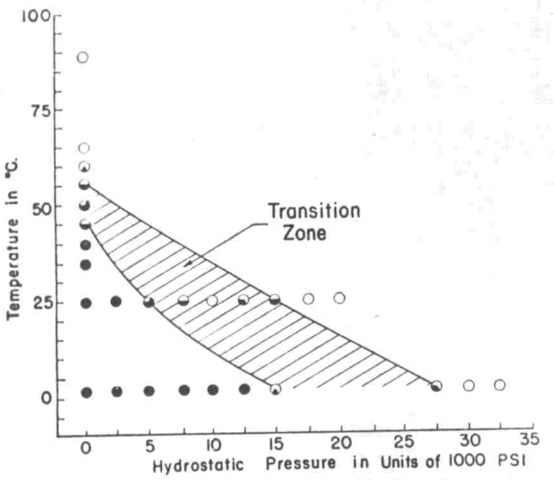

FIG. 2. Temperature and pressure effect on fracture in the transition region. The black portions of the circles represent the fractions of six samples which fractured before 4 msec.

also significant since afterwards the deflection rate started to decrease.

If the transition is defined to occur at the mid point of the transition region, then the transition temperature at atmospheric pressure is ~50°C, that at ~10,000 psi is 25°C, and that at ~21,000 psi is 2°C. However, it should be remembered that pressures above 20,000 psi may be as much as 1,000 psi below the reported value because of the friction between the piston and cylinder as discussed earlier.

DISCUSSION

The results of the present experiment will be compared to those of the more common tensile experiments, since the ratio of the maximum tensile stress σ_m to maximum shear stress τ_m is equal to 2 for both the bend and the tensile tests, and apparently the transition temperatures are essentially the same.

The slope of yield strength vs. temperature curves in the present studies is probably similar to that of Bechtold,[11,12] Fig. 3. The fracture stress is almost independent of temperature for the ranges of interest.[12] The slope of the yield stress curve over this temperature range has essentially the same slope for ASTM grain size No. 5.9 (~500 grains/mm^2) as ASTM grain size No. 7.8 (~1800 grains/mm^2).[12] Bechtold's data refer to 900 grains/mm^2 while the authors' refer to 1600 grains/mm^2. The effect of impurities on the 0.2% yield strength of tantalum (which has similar yield characteristics as molybdenum) is rather large but the slope appears to be changed only slightly over relatively wide ranges of impurity concentrations.[13] As can be seen from Bechtold's data for molybdenum the slope at both 0°C and 50°C is essentially the same over 3 orders of magnitude change in the strain rate. Bridgman[14] found pressure to have negligible effect on the yield stress of molybdenum below 120,000 psi (~8.5 kbar).

All evidence indicates that the required applied stress to cause fracture is raised by the application of a hydrostatic pressure and in fact the change in the fracture stress which is required to lower the transition temperature by 50°C is just equal to the applied hydrostatic pressure of ~20,000 psi as reference to Fig. 3 will indicate. (It is assumed that the yield curves can be extrapolated 50°C below the intersection between yield strength and fracture strength.) It should, however, be pointed out that the transition criterion previously discussed for this experiment involves approximately an 18% strain in the outer fiber so that this transition temperature lies slightly to the right of the intersection between the fracture stress and yield stress curves. However, if this shift is not a function of pressure it will not be important to the discussion. Studies using a smaller strain criterion could further clarify this point.

The effect of applying a hydrostatic pressure P to a homogeneous cubic crystal is to add to any tensile stresses, which might originally be present, a stress of magnitude $-P$ and to leave the shear components unaltered. This result was used in this investigation since the sample material consisted of relatively pure (99.95%) powder metallurgy recrystallized molybdenum of b.c.c. structure and was believed to contain no gross inhomogeneities.

Since the number used to indicate the fracture stress (or yield stress) is the maximum tensile component of the applied stress system (not including hydrostatic pressure) and since the effect of hydrostatic pressure is to reduce all tensile components including the maximum value by the amount of the

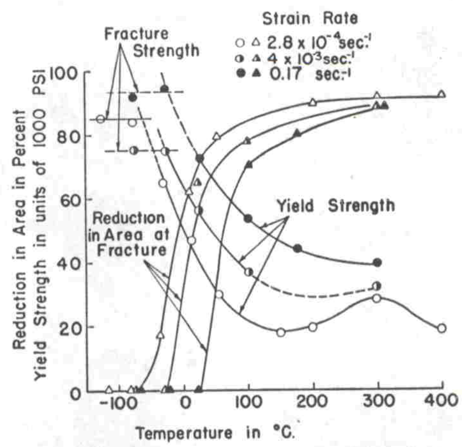

FIG. 3. Effects of temperature and strain rate on the ductility, yield strength, and brittle fracture strength of annealed molybdenum. Grain size, 900 grains/mm^2 (according to Bechtold[11,12]).