THE INFLUENCE OF STRUCTURE AND TEST CONDITIONS ON THE MECHANICAL PROPERTIES OF LOW ALLOY MOLYBDENUM

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It is well known that insufficient low temperature ductility is one of the chief difficulties in the development of molybdenum base alloys. Therefore, determining the ductility at low temperatures on the basis of the temperature of the transformation to the brittle condition $T_X$ is a very necessary test for molybdenum and molybdenum base alloys.

In the majority of research on the low temperature ductility of molybdenum [1-3] bend testing of flat samples was used. A similar method was used for testing welded joints of molybdenum [4].

Normally bend testing requires less expenditure for the preparation of samples than tensile testing and may be done on less powerful test machines, since the force for bending is significantly less than for tensile testing of the same cross-section. If the bend test is recorded by a load-deflection curve, then it makes it possible to determine not only the ductility, but also the strength parameters, the conditional proportional limit $\sigma_{pr}$ and the conditional yield point corresponding to the deformation of the far side to some fixed value, $\sigma_{0.2}$, for example. In some cases there is also the formation of a "yield peak" and it is possible to determine the upper and lower yield points.

The purpose of this work is to compare the strength and bend tests. Since the tests were carried out on molybdenum with various structures and the rate of deformation in testing was varied by two orders of magnitude, it was possible to simultaneously analyze several rules for the change in the strength and ductility parameters in relation to the structure and rate of deformation.

RESULTS

Testing was done on type TsM-2A low alloy molybdenum (0.07-0.15% Zr, 0.07-0.3% Ti, ~0.001% C). Metal sheet 1 mm thick was produced by rolling. A portion of the samples was annealed for an hour at 1300°C in a vacuum of $10^{-5}$ mm Hg to obtain a fine grained structure ($d = 5 \mu$) and the other portion at 1600°C to obtain coarse grain ($d = 53 \mu$).

The nucleus size for the metal in the deformed condition was about $1 \mu$. Annealing of samples for bend and tensile testing was done simultaneously.

Bend testing was done by a three point method with recording of the load-deflection curve on samples $4 \times 1$ mm in...
Fig. 2. Influence of the rate of deformation on the brittle transformation temperature $T_X$ determined in bend testing: A) deformed samples; ■ and □ annealed at 1300°C; ● and ○ annealed at 1600°C; △, □, and ○ transverse samples; ■ and ● longitudinal samples.

Fig. 3. Influence of the rate of deformation on the ratio of the conditional proportional limits in bending and tension. Samples were annealed at 1300°C.

Fig. 4. Influence of the rate of deformation on elongation (○) transverse samples; ● longitudinal samples] and reduction of area [□ transverse samples; ■ longitudinal samples]

The results of bend and tensile testing were compared at similar rates $v$ of movement of the movable clamp of the test machine in tensile testing and of the bending blade in bend testing. The relative rate of deformation of the far side in the bend test method used in the initial stage of deformation is

$$\dot{\varepsilon}_b^b = \frac{6h}{L^2} \dot{u},$$

where $h$ is the thickness of the sample; $L$ is the distance between the supports; and $v$ in bend testing is the rate of movement of the bending blade.

If in tensile and bend testing the rates of movement of the movable clamp of the machine and the bending blade are similar, then we may show that

$$\dot{\varepsilon}_b^b = \dot{\varepsilon}_b^t \frac{6hL_2}{L^2} \approx 0.37\dot{\varepsilon}_b^t.$$