A proportion of the dislocations generated under the original static stress pile up beneath the free surface of the crystal or against obstacles in the slip plane. When the stress is substantially reduced these dislocations tend to move back towards the generating source under their mutual repulsive stresses. This process is resisted by minor 'frictional' obstacles in the glide plane but the application of a fatigue stress, which causes the dislocations to oscillate, assists them to overcome these obstacles thus increasing their mobility. Larger fatigue stresses would result in more dislocation mobility leading to further strain recovery. It is not clear, however, why a dislocation oscillating at the frequencies used in the present work which are much lower than the 'resonance' frequency of a dislocation line, should become much more mobile than a static dislocation. It is possible that the low-frequency oscillations of the large dislocation networks in the crystal may induce high-frequency oscillations in the smaller elements. Alternatively, the additional energy imparted to the dislocation line, even at low frequencies, may be sufficient to assist it in overcoming the minor frictional obstacles in the slip plane. Experiments are being carried out to reveal which of the two mechanisms is in fact responsible for the effects observed.

Recent evidence in support of the concept of the increased mobility of an oscillating dislocation is given by Meleka and Evershed[6] where a fatigue stress was found to increase forward creep and by Blaha and Langencker[7] who observed a decrease in the static stress required for continued glide when a fatigue stress was applied.

A full account of this work will be published elsewhere.

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[1] Boltzmann, L., *S.B. Akad. Wiss. Wien, Ber.*, **70**, 275 (1874).

[2] Tapsell, H. J., London Congress, International Association for Testing Materials, 1 (1937).

[3] Chalmers, B., *J. Inst. Met.*, **61**, 103 (1937).

[4] Ke, T. S., *Phys. Rev.*, **71**, 533 (1947).

[5] Wartenburg, H. V., *Ver. deutsche Physikal. Ges.*, **20**, 113 (1918).

[6] Meleka, A. H., and Evershed, A. V., B.I.S.R.A. Report, *P*/5/59 (1959).

[7] Blaha, F., and Langencker, B., *Acta Met.*, **7**, 93 (1959).

Impact Ductile Molybdenum

It has recently been reported that unnotched single crystals of zone-melted molybdenum are ductile in impact well below room temperature[1]. Although the impurity content of this material was very low it was felt that the improvement may be due to the single crystal structure and not the purity. Some crystals were therefore forged and recrystallized to give a polycrystalline material of grain size 4/cm. The specimens were turned to ¼ in. diameter and electropolished to produce a surface similar to that of the zone-melted crystals. Tested in a 10 ft./lb. Charpy impact machine these gave a 5 ft./lb. transition temperature of —80°C. compared with —140°C. for similar purity single crystals. A graph of the two sets of results is shown in Fig. 1, the points and full line refer to polycrystals and the broken line to single crystals.

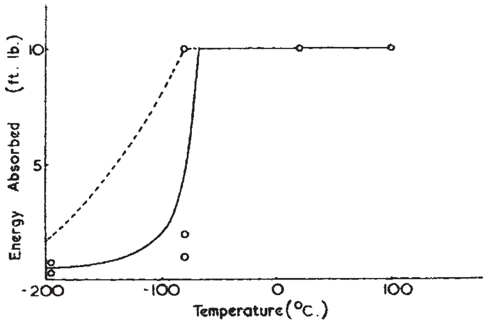

Fig. 1.

The increase in transition temperature may be due to the effect of the grain boundaries or a slightly worked surface layer. No grain boundary facets are apparent in the fracture surface. The transition temperature of recrystallized vacuum-arc-melted molybdenum is about 350°C. under similar conditions. A comparison of the impurity contents in weight per cent of the arc-cast and zone-melted material is given below.

Impurity	Arc-cast	Zone-melted
Carbon	0·01	0·002
Silicon	0·002	0·002
Iron	0·004	0·0001
Copper	0·004	0·001
Chromium	0·001	0·001
Nickel	0·007	0·0001
Cobalt	0·010	0·0002

The oxygen content of both materials is about at the limit of detection of the available vacuum fusion apparatus, approximately 1 part per million.

The surface condition of the recrystallized zone-melted metal was important. Electropolishing improved the impact ductility. Further experiments are in hand to assess to what extent carbon is the impurity responsible for the poor impact properties of arc-cast molybdenum.

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[1] Belk, J. A., *J. Less Common Metals*, **1**, 50 (1959).

ENGINEERING

Strength of a Grooved Stud

It is commonly accepted that an abrupt change of section (such as a circumferential groove in a bar under the action of tension) will lead to a stress concentration at the root of the groove, and hence to a weakening of the bar in excess of that resulting from reduction in sectional area. That the bar is not necessarily weaker, but may be very much stronger, is now well established but is not generally recognized.

I recently needed to design safety studs which would fracture at a load of 29,300 lb. with a maximum coefficient of variation of 1·3 per cent. The studs were 7 in. long and 1½ in. in diameter with a circumferential groove of semi-circular section turned on it with a parting tool. It was found that the studs broke at loads which were 60 per cent greater than those calculated from the tensile strength (28/33 tons/sq. in.) of the material (which was structural steel), and the cross-sectional area. The test results are shown in Table 1.

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