

explosive-metal assembly previously described²⁴ and illustrated in Fig. 1. In this figure the essential parts are shown, including the positions of the foil specimen which are secured in holding plates by press-fitted dowels. Commercial grade 70/30 brass was used for all metal parts of the assembly. A duPont sheet explosive plane wave generator was used to initiate the top surface, AA' , of the explosive. The forces of the explosion accelerated the driver plate in a planar fashion so that the specimen assembly surface, BB' , was impacted simultaneously, thereby producing a planar shock compressive wave.

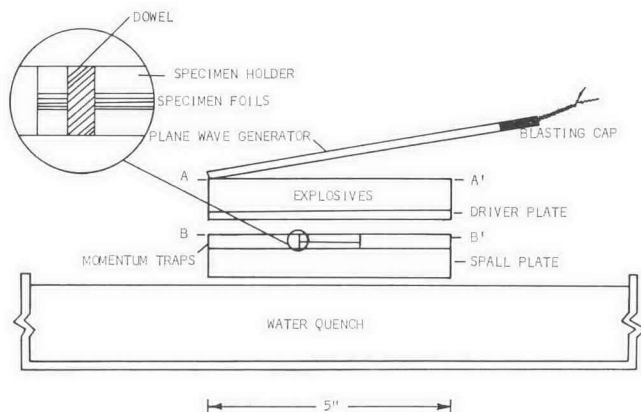


FIG. 1. Experimental apparatus for explosive-shock-deforming metal specimens.

The magnitude of the induced pressure depended on the velocity of impact and was estimated from Hugoniot compressibility data.²⁵ Momentum traps and spall plates were used to prevent undesirable lateral relief and reflected waves from reaching the specimen. Thus the specimens were subject to a planar compressive wave having one-dimensional strain only:

$$\epsilon_x \neq 0, \quad \epsilon_y = \epsilon_z = 0 \quad (1)$$

where x is the propagation direction of the shock wave and normal to the specimen surfaces. Fowles²⁶ has shown that for an elastic, perfectly plastic solid, the one-dimensional strain condition gives rise to a triaxial stress state $\sigma_x, \sigma_y, \sigma_z$ characterized by

$$\begin{aligned} \sigma_x &= P + \frac{2}{3} Y_0 \\ \sigma_y &= \sigma_z = P - \frac{1}{3} Y_0 \end{aligned} \quad (2)$$

The applied stress during impact consists of a hydrostatic component of stress P plus an additional factor on the order of Y_0 , the yield stress of the material as determined in simple tension. In the present work, specimens of pure copper,

Cu-6 wt.% Zn, Cu-10 wt.% Zn, and Cu-20 wt.% Zn were subjected to a shock wave with P of 55 kilobars. Those of Cu-30 wt.% Zn were shock-deformed with P of 50 kilobars. The duration of the shock wave was approximately 2.0×10^{-6} sec in each case. The specimens were recovered in water at room temperature.

Shock-loaded specimens were prepared for transmission electron microscopy by electrothinning in a solution of 35% nitric acid and 65% methanol at -30°C and a current density of 0.5A cm^{-2} . The microstructures were observed by using an Hitachi HU-11A electron microscope operated at 100 kV.

Results and Discussion

The results of the present study of the dislocation configurations produced in copper and α brasses are shown in Fig. 2 and 3. Specifically, Fig. 2 shows the

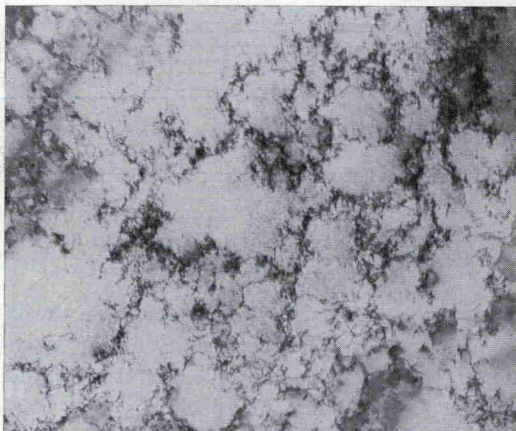


FIG. 2. An electron micrograph showing a dislocation cell structure in pure copper after shock deformation to 55 kilobars. Magnification $34,000 \times$ (reduced 50 %).

formation of a cell structure in pure copper after deformation to 55 kilobars. Some of the α brasses of relatively high SFE also exhibited a cell structure as shown in Fig. 3a and 3b—namely; those copper alloys having compositions of 6 and 10 wt.% Zn. Brasses of low SFE such as Cu-20 wt.% Zn and Cu-30 wt.% Zn are shown in Fig. 3c and 3d to exhibit coplanar dislocations. We can see clearly in Fig. 3 that, under shock deformation conditions, a variation in the SFE produces a variation in the dislocation structure. Furthermore, these substructures are quite similar to those produced in the series of α brasses deformed slowly in simple tension as reported by Thomas.¹¹ In fact, the shock-induced structures observed here are essentially those that would be expected on the basis of