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Letters

Transmission Electron Microscopy of a Superplastic Alloy, Al-78 wt % Zn

New alloys have been developed which can be moulded as easily as plastics at high temperatures and yet are very strong at normal temperatures. Such crystalline materials, showing elongations of several hundred per cent [1] under certain conditions, are called "superplastic". Numerous materials which undergo phase transformations [2], as well as eutectic and eutectoid alloys, exhibit this phenomenon; the Al-78 wt % Zn alloy belongs to the latter class.

In a study of the Al-78 wt % Zn system, thin foils suitable for electron microscopy were prepared by using a Leitz ultramicrotome. Previous attempts to produce such thin foils by chemical etching or electrochemical thinning from the bulk were unsuccessful because of the different etching properties of the aluminium and zinc.

In this letter, transmission electron micrographs of Al-78 wt % Zn foils, prepared by ultramicrotomy, are described. The samples of the alloy in sheet form were pre-cut and mounted in gelatin capsules filled with Scotchcast* for support. Since the maximum area that can be cut with a diamond knife without knife damage is less than 0.5 mm^2, the capsules were dissolved in water after hardening of the Scotchcast, and the remaining block was shaped into a square pyramid with the sample strip located in the apex. The sections obtained were of uniform thickness ($\sim$ 2000 Å), and they formed a ribbon perpendicular to the knife edge on the surface of the water in the collecting trough. Because of the different electron absorption of aluminium and zinc, the contrast observed in the electron micrographs clearly indicates the type of phase present: regions appearing dark are rich in zinc, and light areas are rich in aluminium.

Fig. 1 shows a transmission electron micrograph of Al-78 wt % Zn which was heat-treated at 315° C and slowly cooled in air in an attempt to approach phase equilibrium. The typical pearlite structure with alternating layers of zinc and aluminium-rich phases is readily apparent. Electron microprobe analysis of a similar but

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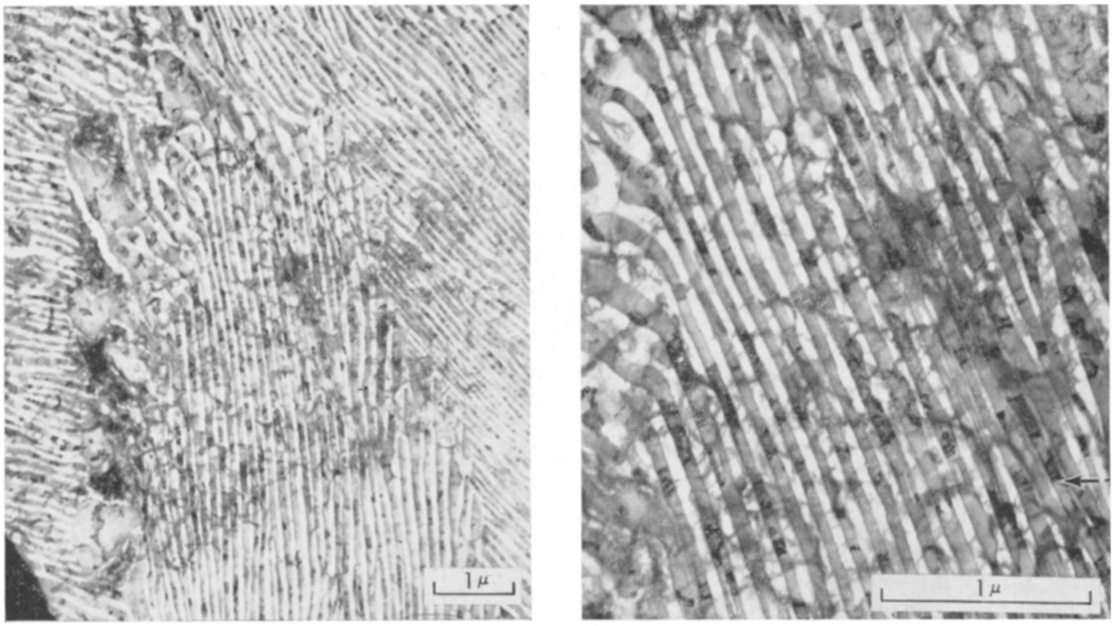
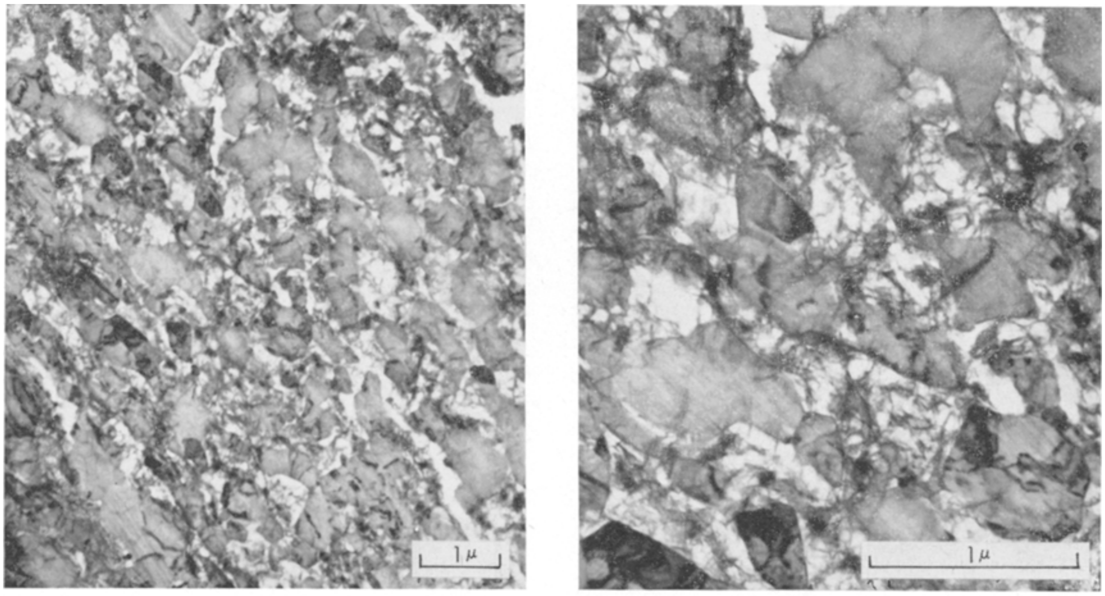
*Brand name, 3M Company.



(a) (b)

Figure 1 Al–78 wt. % Zn, air-cooled after heat-treatment at 315° C. Arrow on (b) shows typical bending contour.

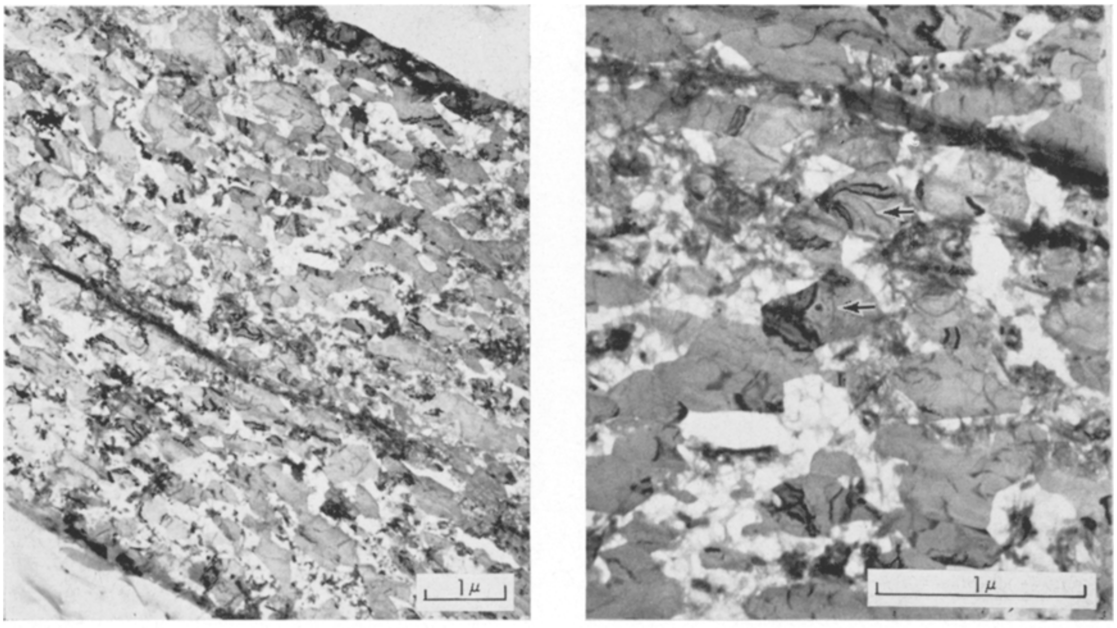


(a) (b)

Figure 2 Al–78 wt. % Zn, water-quenched after heat-treatment at 315° C.

much coarser-grained sample showed the dark layers to be the eutectoid β-phase (essentially pure zinc) and the light phases to be a zinc-enriched α-phase; this was confirmed by selected-area diffraction of the foils.

Upon quenching the heat-treated samples, a drastic change in the distribution of these phases occurs. As shown in fig. 2, the pearlite structure disappears completely and a mixture of aluminium and zinc-rich phases results.



(a) (b)

Figure 3 Al–78 wt. % Zn, quenched and cold-rolled (75%). Arrows on (b) show typical thickness contours.

Fig. 3 is an electron micrograph of a sample which was cold-rolled (75 %) after quenching. An elongation of the grains in the rolling direction can be observed; however, no dependence of grain elongation on the percentage of rolling is seen. Since even the sample which had only been quenched (fig. 2) shows this grain distortion, it was attributed to a pre-annealing treatment.

The sharp contrast lines, especially noticeable in the zinc-rich phase, are caused by diffraction effects due to bending of the foils and local thickness variations. Some folding of the sections parallel to the knife edge can also be observed in the electron micrographs.

While ultramicrotomy has been used successfully in the present study to reveal the distribution of phases, the same technique would not prove as valuable in obtaining information on the actual deformation mechanism in this alloy, since the cutting operation introduces unavoidable strains in the foils.

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Comments on the Letter "A Method for Determining the Thermal and Athermal Components of Flow Stress from Stress Relaxation" by P. Rodriguez (J. Materials Sci. **3** *(1968) 98)*

Rodriguez [1] has recently suggested that the athermal component of the flow stress can be obtained from stress-relaxation in the following manner. A sample is deformed, and at a given strain, the crosshead movement is stopped and load relaxation is observed. The load is then removed in small decrements until the relaxation rate is too small to be detected. The stress at which no relaxation rate is observed was designated the *athermal stress*, σ_μ. The purpose of this communication is to point out that the Rodriguez method can lead to incorrect values of the athermal stress.

The most common method of obtaining the athermal stress for a bcc metal or alloy is to observe the temperature dependence of the flow