The Effect of Working and Heating Eutectic Structures

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With the exception of the work of Tammann and Hartmann,¹ no published information has been found on the structural changes produced in eutectic structures as the result of heating following plastic deformation. In part this lack of information may be due to the fact that many eutectic structures contain an intermetallic compound as a prominent phase, and as a consequence have been considered to be unworkable. For example, Tammann and Hartmann were able to obtain useful data only on those alloys that they could greatly reduce in thickness

cooling in the mold from about the eutectic temperature. The fairly coarse eutectic structure thus obtained was too brittle to work at room temperature without cracking. Fig 1b shows the worked structure obtained by compressing a $\frac{1}{2}$ -in. cube 70 pct in about 15 sec at 550°F and then water quenching. The pronounced changes in the distribution of the two phases produced by heating the worked alloy at 850°F for 1 hr are shown in Fig 1c. Recrystallization of both phases appears to have taken place, and the mechanical properties of the cast alloy

tion, to have a granular structure after heat treatment: Sn-9 pct Zn (98 pct); Cd-82.5 pct Pb (60 pct); and Bi-43.5 pct Pb (90 pct). On the other hand the alloy Al-11.7 pct Si (60 pct) showed no change after heating. Tammann and Hartmann observed a distinct shrinking of the needles in unworked eutectics subjected to heat-treatment. In the present work inappreciable change in the eutectic structure was found on heating undeformed alloys.

In summary, it appears that eutectic structures can be recrystallized into a "spheroidized" condition by heating

FIG 1a—The cast structure of the Pb-33.2 pct Mg alloy; the Mg_2Pb intermetallic compound appears dark and the Mg solid solution light.

Unetched. 1000 $\times$.

FIG 1b—The Pb-33.2 pct Mg alloy reduced by pressing at 550°F.

Unetched. 1000 $\times$.

FIG 1c—The 70 pct reduced Pb-33.2 pct Mg alloy after heating for one hour at 850°F.

Unetched. 1500 $\times$.

by cold rolling. This restriction placed on the investigation of alloys containing intermetallic compounds has been largely removed by the work of Savitskii² which showed that large deformations of such alloys can be produced by relatively slow compression at temperatures near the melting range. It was possible, therefore, to carry out the present work on a range of binary eutectics including one composed of two intermetallic compounds.

The essential results obtained on the alloy systems studied are illustrated by the Pb-Mg eutectic containing 33.2 pct Mg, Fig 1. The cast structure, Fig 1a, was obtained by melting together magnesium of 99.8 pct purity and chemically pure test lead, casting into a heated, small steel mold, and furnace

must have been significantly changed by the working and heat treatment.

Similar results were obtained with the Mg-59.5 pct Bi, Mg-36.4 pct Sn, Mg-65.4 pct Cu, and Bi-40 pct Cd eutectics, only the last of which could be worked at room temperature. Tammann and Hartmann reported a thickening and shortening of the needles of the eutectics which they heated about 10°C below the melting range for 1 hr after drastic cold rolling. They found the following eutectics, given the indicated amounts of reduc-

tion, near the eutectic temperature after severe deformation. If the eutectic contains one or more brittle phases the necessary deformation can be accomplished by pressing at high temperatures. It is reasonable to expect that this tendency towards equiaxed grains from the plate- or needle-like eutectic structure should be general since the energy relations and mode of growth in recrystallization are so different from those that hold for eutectic crystallization.

References

1. G. Tammann and H. Hartmann: *Ztsch. Metallkunde* (1937) **29**, 141-144.
2. E. M. Savitskii: *Doklady Akad. Nauk S.S.S.R.* (1948) **62**, 349-351. Abstr. in *Metal Prog.* (July, 1949) **56**, 126, 128.

Technical Note No. 27 E. Manuscript received July 27, 1949.

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¹ References are at the end of the note.