

X-RAY AND METALLOGRAPHIC STUDY OF RAPIDLY QUENCHED
SILVER-LEAD ALLOYSA. Tonejc and A. Bonefačić
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As can be seen from phase diagram (1), Ag dissolves a small quantity of Pb below the eutectic temperature and a maximum equilibrium solid solubility of Pb in Ag is 2.8 at.% at 600°C. Using the "two-piston" method (2,3), we tried to dissolve more than 2.8 at.% Pb. Electron microprobe analysis of rapidly quenched flakes of Ag-Pb alloys was used in order to ensure a better explanation of the results of the X-ray diffraction measurements.

Experimental

The procedure employed in the preparation of samples, and the X-ray and metallographic investigations were reported previously (3,4,5). The concentrations of Pb in the quenched flakes were determined by means of electron probe microanalysis (5). The amount of Pb in the quenched flakes was about 2.0 to 2.5 times lower than the nominal concentration. The very great difference between nominal and measured concentrations of Pb in quenched flakes probably derives from the fact that the vapour pressure of Pb is more than 1 mm Hg at temperatures of 1100°C from which the liquid Ag-Pb alloys were quenched.

Results and Discussion

The thickness of the resulting quenched flakes varied from a few to 50 μm . The results of the lattice parameter measurements are presented in Fig. 1, where the change in the lattice parameters of the Ag-Pb solid solutions with increasing Pb content is shown. The results obtained by Raub and Polazcek-Wittek (6) and Chiswick and Hultgren (6) are also given.

Each point of the present measurements represents the lattice parameter determined on different quenched flakes for a measured Pb concentration. The errors in the

concentration determination are indicated approximately with error bars.

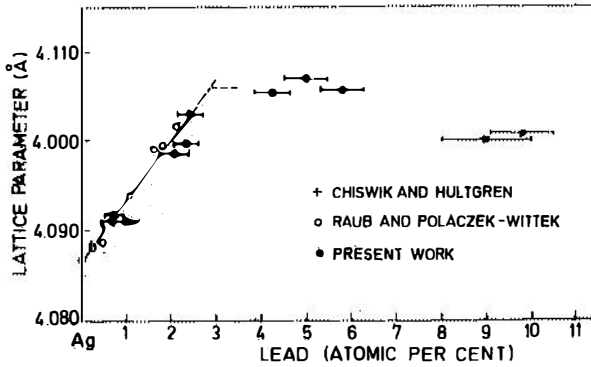


FIG. 1.

Lattice parameters of fcc solid solutions in Ag-rich alloys plotted vs lead concentrations

The lattice parameters of the solid solution up to 2.4 at.% Pb fall on the straight line. No lines of Pb were detected on Debye-Scherrer patterns in this region of Pb concentrations. The results of Raub and Polaczek-Wittek and Chiswik and Hultgren are in very good agreement with our results.

Scanning electron micrographs, using reflected electrons, and PbL_α scanning images showed that in this region of Pb concentration the quenched alloys were very homogeneous, and no traces of undissolved Pb were found (Fig. 2a and 2b). The lattice parameters of quenched flakes with a Pb content of 4 to 6 at.% fall out of the inclined straight line. This behaviour of lattice parameters was due to undissolved Pb in the quenched flakes, and was confirmed with the aid of scanning images and of scanning electron micrographs (Fig. 3a and 3b).

Extrapolation against the inclined straight line (Fig. 1) gives a value of 2.8 at.% Pb. This value agrees with the maximum equilibrium solid solubility of Pb in Ag determined in the Ag-Pb phase diagram.

Debye-Scherrer patterns of the quenched flakes with Pb content exceeding 6 at.% show both L_α-Ag and Pb lines. The scanning images and scanning electron micrographs of these flakes showed regions which have a higher Pb content and

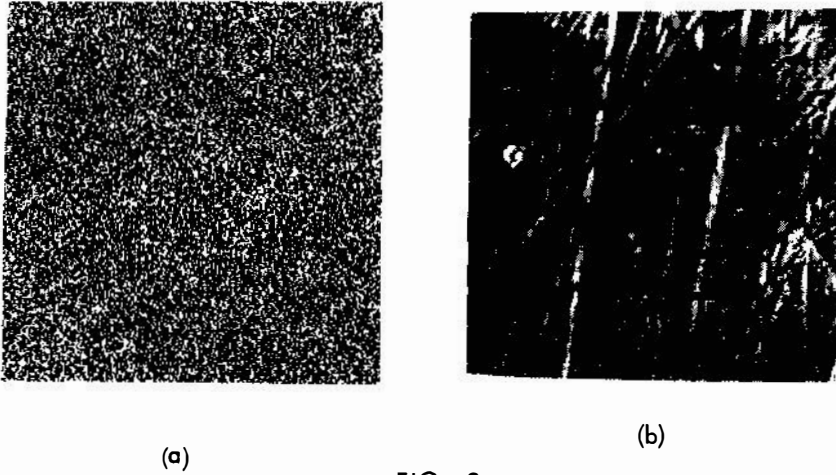


FIG. 2

- (a) PbL_{α} scanning image of very rapid quenched Ag-2.4 at.% Pb alloy, showing the homogeneous distribution of undissolved Pb. Magnification 840 x.
 (b) Scanning electron micrograph of the same area as under (a). No traces of undissolved Pb are visible. Magnification 840 x.

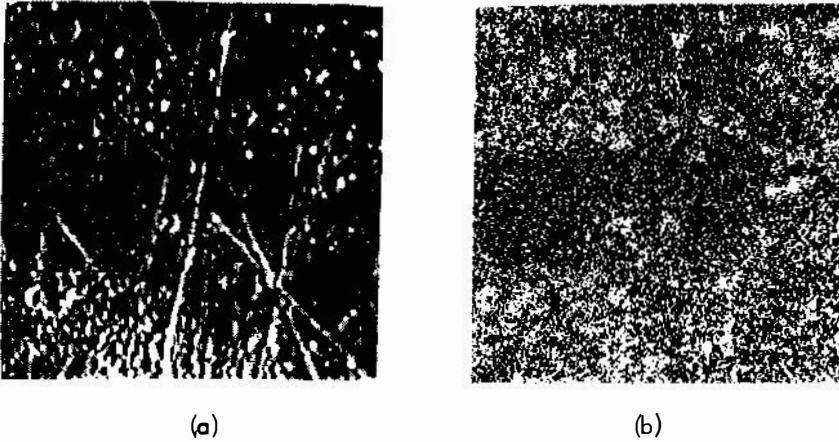


FIG. 3

- (a) PbL_{α} scanning image of very rapidly quenched Ag-4.9 at.% Pb alloy showing regions with higher Pb content. Homogeneous regions are also present. Magnification 840 x. (b) Scanning electron micrograph of the same area as under (a). Regions with higher Pb content represent small globules of undissolved Pb. Regions with dissolved Pb are also visible. Magnification 840 x.

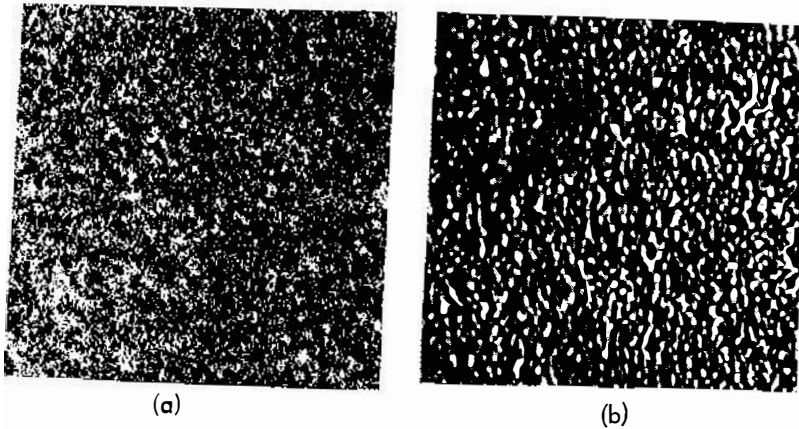


FIG. 4

a) $Pb_{L_{\mu}}$ scanning image of very rapidly quenched Ag-9.0 at.% Pb alloy showing regions with higher Pb content uniformly distributed over the whole flake area. Magnification 840 x. (b) Scanning electron micrograph of the same area as under (a). The whole flake contains small globules of undissolved lead. Magnification 840 x.

are uniformly distributed over the whole flake area (Fig.4a and 4b).

In spite of the very high cooling rates attained in the experiments, Ag-rich Ag-Pb solid solutions were obtained only up to 2.8 at.% Pb. This value agrees with the maximum equilibrium solid solubility of Pb in Ag determined in the Ag-Pb phase diagram.

The obtained "classical" result may be due to the size-factor which is unfavourable for the Ag-Pb system (difference in atomic diameters is 20%). From the fact that all flakes of definite Pb content, regardless of thickness, in our interval from a few. to 50 μm , showed the same results in lattice parameter measurements and in electron microprobe analysis, we assume that in the quenching process from an initial temperature of about 1200°C two melts are formed before the solidification begins: Ag-2.8 at.% Pb as the first melt, and the excess of Pb as the second melt. In the further quenching process this mixture of two melts becomes solidified and quenched to room temperature where we obtain two phase alloy: Ag-2.8 at.% Pb solid solution, and undissolved Pb.

Acknowledgements

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References

1. M. Hansen and K. Anderko, *Constitution of Binary Alloys*, p. 40, 2nd ed., McGraw-Hill Book Co., New York (1958).
2. J. Dixmier and A. Guinier, *Mem. Sci. Rev. Metall.*, 64, 53 (1967).
3. A. Tonejc and A. Bonefačić, *J. Appl. Phys.*, 40, 419 (1969).
4. A. Tonejc and A. Bonefačić, *Trans. AIME*, 245, 1664 (1969).
5. D. Kunstelj and A. Bonefačić, *Metallography*, 2, 329 (1969).
6. W.B. Pearson, *A Handbook of Lattice Spacings and Structures of Metals and Alloys*, p. 298, Pergamon Press LTD., Oxford (1964)

DISCUSSION

- H. Jones Surely it is just a matter of the incipient miscibility gap indicated by the characteristic form of the liquidus curve for Ag-rich alloys.
- A. Tonejc : Yes.
- P. Duwez : Another case of non-miscibility is Cd-Zn.