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MICROHARDNESS OF RAPIDLY QUENCHED ALUMINIUM AND Al-0,67 at % Fe ALLOYS

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Introduction

The present study is concerned with microhardness measurements carried out on flakes of Al (99,997% purity) and Al-0,67 at% Fe quenched from the liquid. The behaviour of the flakes after isochronal and isothermal annealing was observed by means of microhardness measurements and compared with the results obtained by means of X-ray diffraction and electron microscopy.

Experimental Procedure

The procedure employed in the preparation of alloys, and the quenching technique have been described previously (1,2). The resulting quenched flakes were approximately circular (5-30 mm^2 in surface and 10-30 μm in thickness). The quality of the flakes was studied by X-ray conctact microradiography (3) and X-ray diffraction. Non-porous specimens, free of iron inclusions and precipitations were chosen for microhardness investigations. The homogeneity of several samples and the concentration of the solid solution were controlled by electron microprobe analysis (4). The decomposition of the solid solution during treatment was examined by means of X-ray analysis (1) and electron microscope technique (4).

The microhardness data were obtained at room temperature using Zeiss equipment with a 136°-diamond pyramid indenter with a 10 g load. The measurements were restricted to flakes with bright and smooth areas. The heating at temperatures up to 200°C required for the isochronal (10 min) and isothermal annealing was ensured by placing the flakes into oil baths which were already at the desired temperatures. For annealing at temperatures exceeding 200°C, the flakes were placed into Pyrex capsules and put into a furnace with nitrogen atmosphere. After each annealing the flakes were air quenched.

Results and Discussion

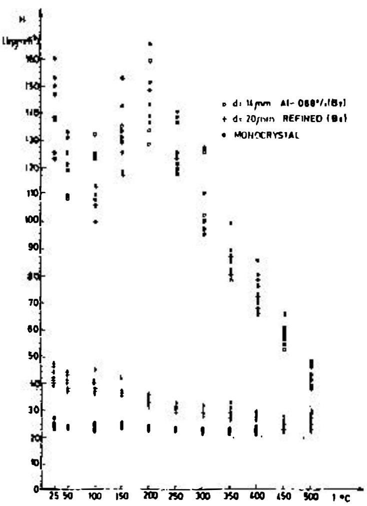

FIG. 1

The results of hardness measurements after isochronal annealing of pure aluminium flakes and of flakes containing the Al-0,67 at% Fe solid solution are represented. The hardness of an aluminium single crystal is also represented in the diagram.

The isochronal annealing of pure aluminium flakes caused a slight decrease in microhardness, without however reaching the microhardness value of the aluminium single crystal even at 500°C. The microhardness of the solid solution decreased at 100°C, but once this temperature was reached it began to increase, to reach its maximum value at 200°C. With further annealing the microhardness again decreased. X-ray and electron microscope measurements showed that the softening of the alloy was caused by the precipitation of the Al_6Fe (at 300°C) and Al_3Fe (at 450°C) phases. The initial increase in hardness indicates that some process occurred which however did not effect the lattice parameter which remained unchanged at those temperatures. This process is now being studied.

Isothermal annealing of pure aluminium flakes, except for a slight decrease at the beginning, had practically no effect on microhardness (Fig. 2). The Al-0,67 at% Fe solid solution, left at room temperature for two months, did not show any change in microhardness.

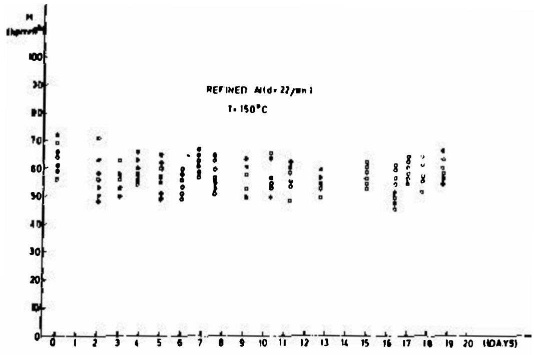

FIG. 2

At room temperature the alloy proved very stable, which agreed with the X-ray and electron microscope measurements. At temperatures up to 200^{o}C microhardness mildly increased at the beginning, to remain constant afterwards (Fig. 3. and 4). At temperatures exceeding 300^{o}C microhardness decreased at first rapidly and subsequently at a slower rate, remaining constant after two hours (Fig. 5). At these temperatures precipitation of the Al_6Fe metastable phase (at 300^{o}C) and of the Al_3Fe stable phase (at 450^{o}C) occurs, which explains the decrease in the hardness of the alloy. Once the precipitation of the stable phase (Al_3Fe) is completed, hardness remains constant.

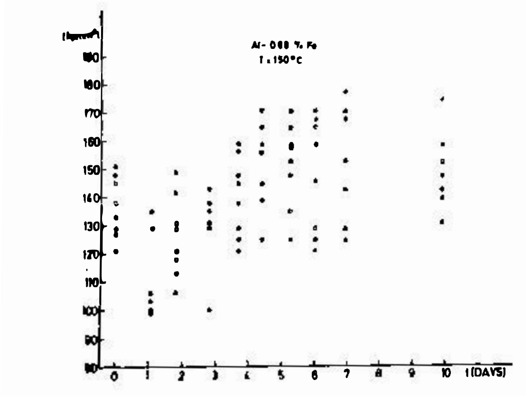

FIG. 3

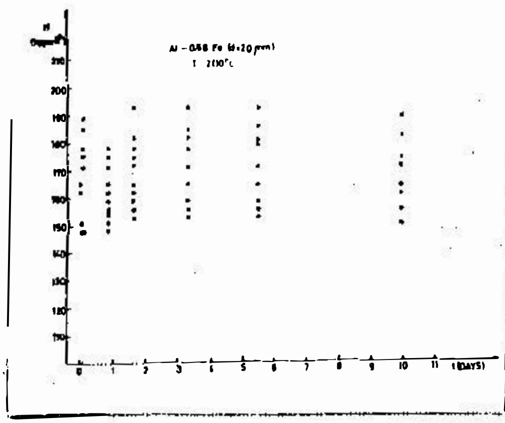

FIG. 4

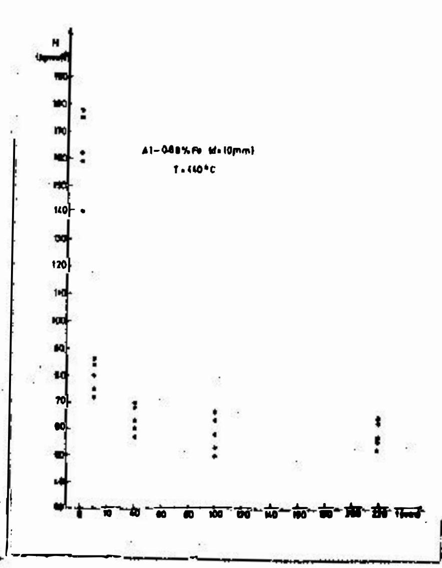

FIG. 5

Acknowledgements

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