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Preliminary results of a further X-ray investigation of Cu–Fe–Ni alloys.

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In a recent paper, Geisler & Hill (1948) discuss the effects observed in X-ray diffraction patterns of alloys of the age-hardening type, and conclude that, in the early stages of ageing, these are best interpreted as arising from particles in the form of 'stringlets' or 'platelets'. Three Laue conditions determine the direction of diffraction in the normal case; for such particles only one, or two, Laue conditions are rigorously obeyed. This explanation is preferred by the above authors to others involving periodic segregation in the lattice prior to precipitation.

It may be of interest, therefore, to give a brief preliminary report of a further investigation of a Cu–Fe–Ni alloy which shows the 'side bands' first reported by Bradley (1940) and later investigated by Daniel & Lipson (1943, 1944).

Powder specimens of the alloy $Cu_{10}Fe_3Ni_7$ were prepared both as-quenched from the single phase state, and after quenching followed by annealing for various periods at temperatures between 550° and 800° C., in which range of temperature the equilibrium structure is two-phase.

Debye-Scherrer patterns were made from these specimens using Fe $K\alpha_1$ radiation, the α_2 component being eliminated by the use of a focusing monochromator. This technique removes a major source of uncertainty in the interpretation of the diffraction patterns, namely that due to the extensive overlapping of main lines and sidebands which results when both α_1 and α_2 components of the K radiation contribute to the formation of the pattern. Also the background is very low and flat in the patterns made with the monochromator, and this is of great importance in obtaining accurate photometric measurements, especially for weak diffuse sidebands.

The patterns of the as-quenched specimens show a single face-centred cubic phase, while those of specimens given very long annealing treatments reveal two face-centred cubic phases having a small difference in lattice parameter. After annealing for moderate periods, the patterns are consistent with the existence of the structure proposed by Bradley, namely, one consisting of two tetragonal phases, Cu-rich and Cu-poor, having c/a ratios slightly greater and less than unity. These phases co-exist with the original lattice for a considerable period, growing in amount as annealing proceeds. They are arranged in 'platelets' whose small dimension is in the c direction and which are coherent with each other and the unchanged matrix on the tetragonal basal planes. Similar structures have been reported for the Cu–Ni–Co alloys by Geisler & Newkirk (1948).

However, the patterns from alloys annealed for short periods (e.g. 10 min. at 800° C., 30 min. at 650° C.) show only weak and diffuse sidebands much further separated from the main line than the lines arising from the tetragonal phases. As annealing proceeds, the sidebands on the corresponding patterns become more intense and move closer to the main line until they reach the separation corresponding to that of the two tetragonal phases.

This behaviour could be explained in various ways. First it might be due to the existence in the lattice of a periodic variation in composition prior to the separation into the two phases, the wavelength of the periodicity becoming greater for longer times of annealing. Alternatively, it might be a consequence of the existence of particles of the two tetragonal phases, too small to give appreciable diffraction alone, but arranged in approximately regular groups, and so modulating the original structure. The particles grow during annealing until they give rise to diffraction at the normal angle for each phase. As the side-bands are very broad, neither a strict periodicity nor a strictly regular arrangement would be expected.

The difference between these two explanations may be largely one only of terminology. A regular arrangement of pairs of particles of the two tetragonal phases, described above, coherent with the cubic lattice on common (001) planes, would constitute a periodic variation in composition and lattice parameter in directions normal to this plane. However, the parameters of the particles parallel to the (100) and (010) planes differ from those of the parent lattice. Either they will be incoherent with the parent lattice along these planes or else there will be boundary volumes in which the parameters change gradually from those of the original lattice to those of the new phases. In this second case one would expect that the boundaries between the particles of the two different tetragonal phases with each other and the cubic lattice on the (001) planes would also be indefinite. The manner in which such a system is to be described depends on the definition of a 'particle'. The important point is that the whole lattice diffracts as though a periodic variation were present.

A third explanation would be that the particles of the new phases formed initially have a larger tetragonality than at a later stage. This is physically unlikely as it could arise only from a larger initial difference in composition (which would not be expected from the phase diagram), or from bulk strain imposed on the particles by the parent lattice and altering as the particles grow. This is also unlikely as the total volume of the two tetragonal phases is very closely that of the lattice from which they form. Coherency strains, which would be most effective in altering the parameter in the earliest stages, would decrease rather than increase the tetragonality.

A detailed account of the investigation will be published later.

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