at. % Zn in the Cu-Zn system [3]. The similarity of these two slopes suggests that the tendency toward martensite formation in the two systems is not as disparate as had been previously thought [1]. The two alloy systems only appeared to behave differently because the earlier investigators [1, 2] either did not study alloys low enough in Zn content (i.e. Pops and Massalski [1]), or they did not use low enough temperatures (i.e. Brown and Stewart [2]). The present experiments demonstrate, however, that even if Brown and Stewart had produced martensite at low temperatures, they would not have observed it at room temperature because it would have reverted to β' phase during heating.

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Crystallisation in Vacuum Evaporated Germanium Films

Germanium films (~800 Å thick) grown onto NaCl single crystal and formvar substrates at room temperature by vacuum evaporation techniques are found to have an amorphous structure. The amorphous to crystalline transformation induced by electron beam irradiation inside an electron microscope showed random orientation immediately after crystallisation. Further bombardment caused recrystallisation in the film and their electron diffraction study revealed the predominance of (1 1 2) orientation.

It is well known that thin films of certain metals and metal oxides grow in the metastable phase having amorphous structure under suitable conditions of the film deposition. The amorphous structure of the metastable phase is known to undergo transformation upon annealing these films [1]. Recently a few papers [2–5] have appeared in which the crystallisation in amorphous films has been reported to be induced by electron irradiation. Although the amorphous structure of vacuum-evaporated germanium films and their transformation to the crystalline state, by annealing as well as by ionic irradiation [6], has been reported previously, there does not appear to have been a report on the type of transformation and the various stages involved in these films by electron irradiation. In the present communication the study of the amorphous to crystalline transition in vacuum-deposited germanium films by electron microscopy and electron diffraction techniques is described with a particular reference to the process of transformation involved in it.

Germanium films of about 800 Å thickness were prepared on freshly air-cleaved NaCl and formvar substrates maintained at room temperature (~25° C) in a vacuum of the order of 10^{-5} torr. The electron microscopic and electron diffraction examination of the as-deposited films showed structureless features and a few broad haloes respectively, indicating amorphous structure (fig. 1). However, thin films with a very small crystallite size also yield such diffraction patterns and structureless features, and therefore, the possibility that these vapour deposited films are micropolycrystalline in structure, cannot be

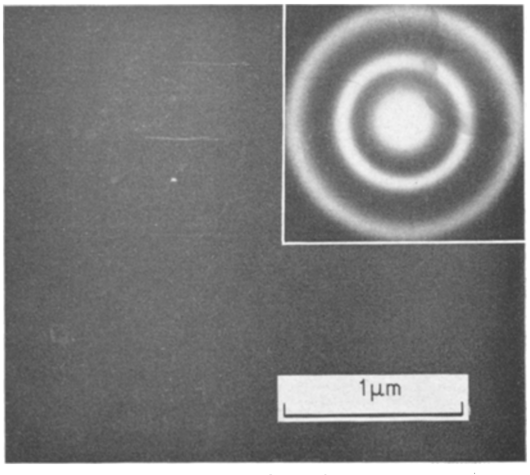

Figure 1 Electron micrograph and electron diffraction pattern (inset) of amorphous germanium film grown on NaCl at room temperature.

ruled out. In order to determine whether as-grown films are amorphous or micropolycrystalline in structure the mode of amorphous crystalline transition by electron bombardment was studied *in situ* by electron microscopy. To study the effect of electron irradiation, a portion of the film in a central region of the grid mesh was chosen and exposed to an electron beam of 80 kV energy. However, as the intensity of the beam was gradually increased, it was observed that beyond a certain limit, nuclei suddenly started to grow in the film until ultimately large grains were formed. The electron diffraction pattern of such regions showed polycrystalline structure. Fig. 2 shows the electron micrograph and electron diffraction pattern (inset), of the same region of the film shown in fig. 1, after electron irradiation. Further irradiation with an intense electron beam caused grain growth and recrystallisation and the electron diffraction study revealed the predominance of (112) orientation in them. Fig. 3 shows the electron micrograph and diffraction pattern (inset) of the film which was recrystallised by intense bombardment. The initial nuclei lose their identity after crystallisation has taken place indicating the evidence of liquid like behaviour at the growth interface. An examination of fig. 2 reveals that once the nucleation has taken place, the crystallites continue growing in size. It is of interest to point out that once the nuclei are formed initially in the film, further reaction is quite fast and finally the recrystallisation takes place rather spontaneously.

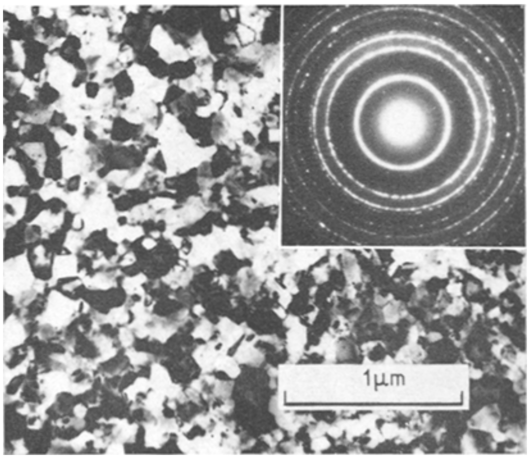

Figure 2 Electron micrograph of the same region as of fig. 1 after electron irradiation showing crystallisation. The electron diffraction pattern (inset) of the film shows polycrystalline structure.

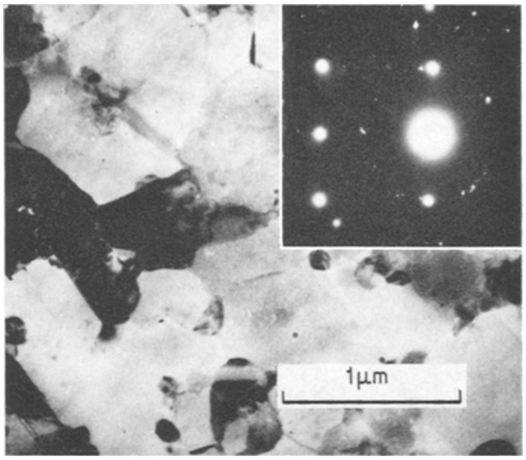

Figure 3 Electron micrograph of the same region as of figs 1 and 2 after electron irradiation for a longer period showing recrystallisation in the film. Inset represents the electron diffraction pattern of the film showing (112) orientations.

The phase transformation in the germanium thin films was also studied by heating in an external vacuum furnace. Films annealed at different temperatures, between 300 and 500° C showed that the crystallisation started taking place at ~350° C and the number of initial nuclei per unit area are found to be the same at different annealing temperatures indicating that the rate of nucleation is almost independent of temperature. Further study has revealed that the growth rate of nuclei is a function of temperature and it increases with increase in temperature. It has been pointed out that the amorphous to crystalline transition by beam irradiation is quite spontaneous. Moreover the amorphous to crystalline reaction in the present case is exothermic [7] with 2.75 kcal/g atom heat liberated during the course of the process and hence accelerates the transition already in progress.

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Short Notices

Magnetic Properties of Materials

Editor Jan Smit

One of life's minor disappointments is that of seeing the name of one's favourite author on the spine of a book only to discover inside that he is not its author but its editor. Having made this remark it is only fair to point out that Professor Smit, in addition to contributing two excellent chapters himself, has achieved an unusually successful synthesis and has been excellently served by his contributors. The magnetic properties described in this book are essentially dynamic properties. There is, apart from thin films, no discussion of metallic systems and no chapter on permanent magnet alloys.

The virtues and weaknesses of multiple authorship are clearly seen in the early chapters. The first is a concise and quite brilliant introduction entitled "Some Concepts in Ferromagnetism" written by the editor himself. The second chapter "Crystallography, Chemistry and Technology of Ferrites" by Gerhard Winkler, subjects the reader to the most abrupt change of gear in the whole book. Yet this is an excellent contribution. There is just the feeling that in a book by a single author the transition would have been made via a description of the electronic structure of 3D elements, the effects of the crystal field in determining ionic site preferences and a reasoned plea that the solid state theorist's theory will be more pertinent if he appreciates the chemical and crystal-growth problems of ferrites and garnets. Unfortunately there remains the equally strong feeling that such an author would be quite unable to provide an account as authoritative as Dr Winkler's.

The magnetic properties subsequently discussed are: "Ferrites at Radio Frequencies" (Jan Kerweel), "Magnetic Properties at Microwave Frequencies" (Jan Smit), "Magneto-optical Properties of Magnetic Crystals" (J. F. Dillon Jr.), "Square Loop Ferrites" (R. S. Weiss), "Magnetic Materials for Recording Tape" (J. C. Mallinson) and "Thin Films" (S. Middlehock). The authors are all experts and write with authority and distinction. The paucity of references more recent than 1966 is rather alarming. However, the various sections aim to present the fundamentals rather than the most recent developments. This they achieve without exception. Whether they collectively make a successful book is largely a matter of personal definition or prejudice.

E. W. L.

Magnetic Domains

R. S. Tebble

(Methuen and Co. Ltd 1969) 93 pp, £1·25

This book provides a very elementary introduction to the subject of magnetic domains. In a brief introductory chapter a few basic properties of ferromagnets are discussed, along with a summary of the principles of domain formation. There follow chapters devoted in turn to methods of domain observation, the energy contributions in magnetic crystals, domain structure, and its relation to the magnetisation curve. The final two chapters describe the more particular topics of single domain particles and thin films. These include a brief discussion on the use of the ideas