

situation found for dilute solutions of sulphur in hexamethylphosphoramide [9], whereas for solutions of sulphur in primary amines, Raman spectra reveal the presence of several polysulphides in addition to S_3^- [11].

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Domain structure of amorphous Nd—Co thin films

Domain structure and magnetic anisotropy of rare earth—cobalt films were investigated by several authors. Investigations concerned mostly amorphous thin films of Gd—Co alloys [1–5]. In this work domain structure in evaporated Nd—Co thin films is investigated.

The films were obtained by vacuum evaporation of two different alloys. The alloys were obtained by melting the stoichiometric quantities of pure metals in atomic ratios of Nd:Co of 2:7 and 2:17 in a vacuum furnace. Compositions of the obtained alloys were controlled by chemical methods. Impurities of other metals were smaller than 0.3%. Glass and mica were used as the substrates, and evaporation was carried out at 300 K.

Some of the films were investigated immediately after deposition and the rest of films after a one month annealing process at room temperature. Investigations made by means of an electron microscope showed that the as-deposited films

were amorphous and had a smooth surface. The domain structure of the films was investigated by the Lorentz microscopy and the Kerr effect methods. The thickness of the films was about 100 nm.

The surface of the film was oriented perpendicular to the electron beam during the domain structure observations by the Lorentz microscopy method. The influence of the external demagnetizing field direction oriented in the plane of the films on the domain patterns was observed. This observation brought us to certain conclusions about the type of the magnetic anisotropy of the films. The domain patterns of the as-deposited films were characteristic for both compositions of the films, and are shown in Fig. 1. The direction of magnetization was determined on the basis of the contrast in areas between the domains, and from contrast observed in investigations made by means of the Kerr effect method. It was ascertained that the domains were separated by 180° walls. The domain patterns of the films enriched with Co did not depend on the direction of the demagnetizing field. In these films zigzag-

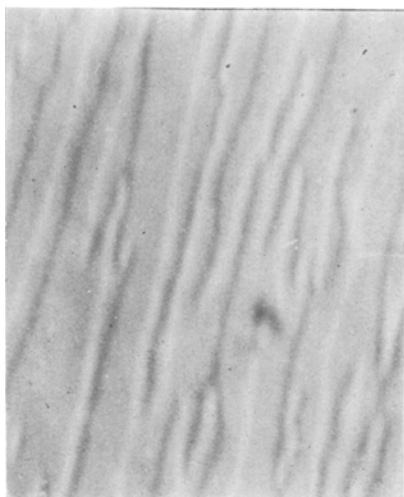


Figure 1 Typical domain patterns of the as-deposited films ($\times 3500$).

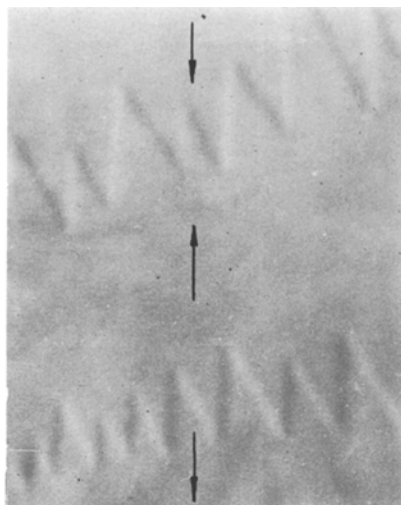


Figure 2 Zigzag-shaped domain walls which were observed in the films enriched in Co. Arrows mark the magnetization direction of the domains ($\times 3500$).

shaped domain walls were found to exist (Fig. 2). Williams and Sherwood [6] have found similar domain structures existing in polycrystalline films of iron. In our case the inter-domain area contrast can be explained assuming that the orientations of magnetization direction in adjoining domains are as marked in Fig. 2. These orientations are in agreement with those resulting from the investigations of Williams and Sherwood and correspond with the orientations of magnetization direction in those parts of the films where elongated domains existed. Therefore we can conclude that the films enriched with Co have relatively strong uniaxial anisotropy, and the direction of easy magnetization is parallel to the long axis of the elongated domains.

On the other hand the as-deposited films enriched with Nd have weaker magnetic anisotropy. In this case the direction of the long axis of the elongated domains depended on the direction of the external demagnetizing field. We have observed that all possible orientations of the easy magnetization direction are enclosed between two straight lines forming an angle of 40° in the plane of the films.

After one month annealing at room temperature essential changes in domain structure of the films were observed. There were several small areas of the films enriched with Co where the direction of magnetization was almost perpen-

dicular to that in the other parts of the films. There was a distinct change of structure in the evaporated Nd_2Co_7 films (Fig. 3). Herd and Chaundhari [3] had found similar structures existing for Gd-Co films which were relatively rich with gadolinium, with in-plane magnetization. The annealing of the amorphous Nd-Co films at room temperature changes the character of the magnetic anisotropy induced by the evaporation process. Electron diffraction patterns for these films were the same as for as-deposited film.

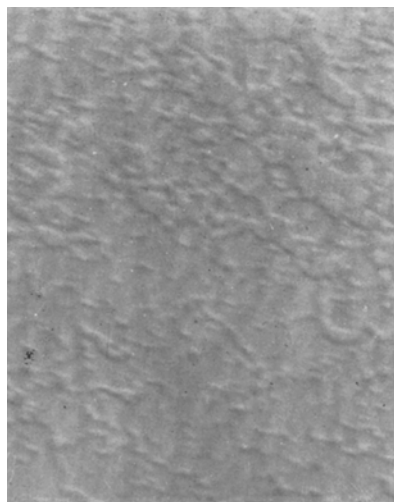


Figure 3 Domain patterns of the films enriched with Nd, annealed at room temperature ($\times 2500$).

The mechanism of inducing uniaxial anisotropy in the plane of the films will be the subject of separate investigations. Analysis of the changes of the type of anisotropy in annealed films needs supporting with structural investigations. Investigations of the influence of high temperature annealing of films on their anisotropy and domain structure have been undertaken.

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Strength versus nitrified density and microstructural design of reaction-bonded silicon nitride

This letter is intended to add information and direction to the comments of Rice [1] on the observations of Jones and Lindley [2, 3], which were published in this journal. Reaction-bonded silicon nitride (RBSN) is a brittle material and as such its strength is a strong function of the size and distribution of flaws. It is agreed that reducing the overall volume fraction of porosity will result in an increased strength. There is, however, disagreement as to whether the strength can be significantly increased by reducing the average pore size and controlling inhomogeneities in the distribution of pores without changing the volume fraction of porosity.

Rice contends that although a reduction in the size of pores at a given volume fraction porosity could lead to an increase in strength by increasing Young's modulus and the fracture energy, there will be no overall improvement because pore clustering and occasional oversized pores will continue to control strength. In other words, no significant reduction in the size of the weak links can be re-

alized by controlling microstructure. Rice states that except for unusually low strengths (due to poor nitriding, impurities, etc.) variations in strength are simply due to variations in volume fraction porosity.

On the other hand, Jones and Lindley have compiled evidence showing that nitrified density, regardless of green density, is directly related to strength. Since a particular nitrified density may contain different volume fractions of porosity depending on green density (and therefore different volume fractions of porosity can lead to a constant strength), they suggest that improvements in strength using microstructural design are very possible.

Baumgartner [4] points out that there is apt to be a maximum green density which can successfully be nitrified without unreacted Si cores remaining. Thus beyond the limiting higher density, efforts other than increased density (e.g. microstructural design or flaw size distribution control) must be employed.

We are in agreement with Jones and Lindley and Baumgartner here. The very complexity of RBSN makes it a material most susceptible to