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CONTRIBUTION TO THE STUDY OF THE CREEP EFFECT IN THIN AMORPHOUS ELECTRODEPOSITED CoP AND NiCoP FILMS

К ВОПРОСУ О ПОЛЗУЧЕСТИ В АМОРФНЫХ ТОНКИХ ПЛЁНКАХ ЭЛЕКТРОЛИТИЧЕСКИХ ОСАДКОВ CoP И NiCoP

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The results of a number of works prove that in permalloy thin magnetically anisotropic films subjected to the simultaneous influence of the dc magnetic field in the direction of the easy magnetization axis of the film and the varying ac or pulse magnetic field in the direction of the hard magnetization axis of the film, the changes in magnetization of the film may be caused — under suitable conditions — by slow motion of the domain walls (effect "creep"). As far as we know, this effect has not yet been observed on amorphous thin magnetic films.

We prepared amorphous thin magnetic films and bulk alloys CoP and NiCoP by electrodeposition under the simultaneous influence of a suitable magnetic field applied in the plane of the subtrate, onto which the film was deposited. The technology of preparation and some physical properties of these materials are described in [1].

By means of the magnetooptic method using the Kerr longitudinal effect [2] we observed in the CoP and NiCoP thin films the existence of the slow motion of the domain walls, the so called "creep" [3], which is typical for unaxial permalloy anisotropic polycrystalline films.

Figs. 1a and 1b show curves of constant velocities of the domain wall in the plane of the two magnetic fields H_L and H_T, perpendicular to each other, on two thin amorphous CoP and NiCoP films; H_L is the dc magnetic field in the direction of the easy·magnetization axis of the film and H_T is the ac magnetic field with the frequency of 50 Hz, perpendicular to the dc field. The figure at each curve indicates the velocity of the domain wall motion (in micrometers/sec). The dependence H_w is the curve of the field of the domain wall start. It can be seen from this figure, that the curves of constant velocities for CoP and NiCoP are different at higher velocities, but the effectivness of the "creep" [3] remains almost the same. There is only a relatively small region, where no "creep" is observed. As it is known, similar curves were observed on polycrystalline unaxial permalloy films [3, 4], thus it can be assumed that the mechanism of the "creep" is the same in both cases.

Fig. 2a and 2b show the hysteresis loops, obtained by means of the hysteresisgraph in two directions, perpendicular to each other, and the domain structure is shown in Fig. 2c. It may be seen from these loops as well as from the observations of the domain structure by means of the Kerr longitudinal magnetooptic effect, that the thin films ($D \doteq 0.16$ μm) of the amorphous CoP and NiCoP alloys show anisotropic properties similar to those of the unaxial permalloy films.

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Fig. 3a and 3b show the hysteresis loops in two directions, perpendicular to each other, obtained on thick films, resp. foils with $D > 1$ μm. The domain structure observed on these samples by the method of powder patterns is shown in Fig. 4. These loops as well as the domain structure indicate the existence of the slight anisotropy of the magnetic properties of these samples on magnetizing them in the plane of the film. The domain structure in the remanent state, obtained by the method of powder patterns, is similar to the structure observed by other authors [5]. The creep effect has not been observed on these samples.

The obtained results indicate the different behaviour of the thin and thick films, resp. foils.

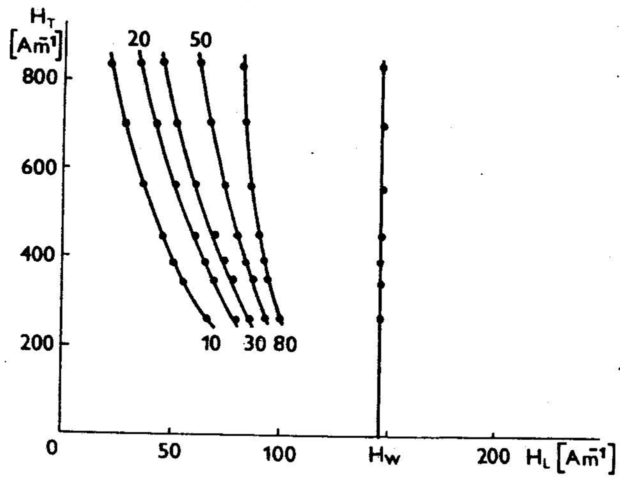

Fig. 1a. Curves of constant velocities for the amorphous thin CoP film with the thickness of ~0.3 μm. The figure at each curve indicates the domain wall velocity in μm/s.

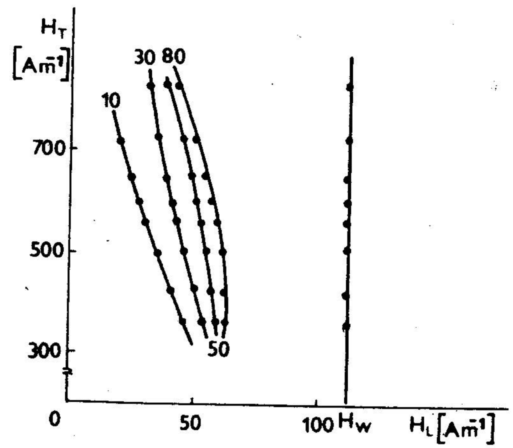

Fig. 1b. Curves of constant velocities for the amorphous thin NiCoP film with the thickness of ~0.15 μm. The figure at each curve indicates the domain wall velocity in μm/s.

Fig. 2a. Hysteresis loop of the amorphous CoP film with the thickness of ~0.3 μm, recorded in the direction of the magnetic field applied in the process of preparation.

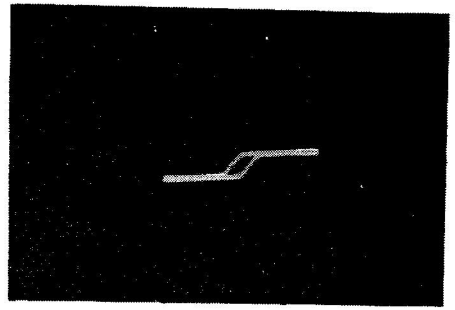

Fig. 2b. Hysteresis loop of the same film as in Fig. 2a, recorded in the direction perpendicular to the magnetic field applied in the process of preparation.

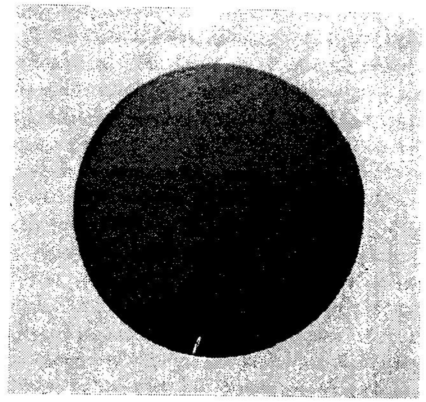

Fig. 2c. Domain structure obtained by the method of the longitudinal Kerr effect on the same sample as in Fig. 2a.

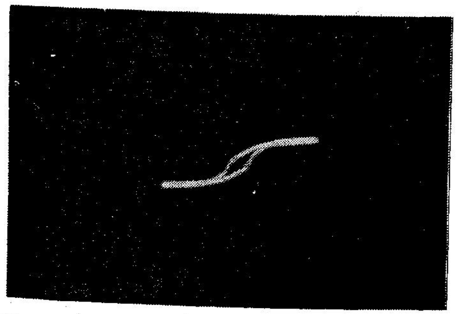

Fig. 3a and 3b. Hysteresis loops obtained on the amorphous foil CoP with the thickness of ~5 μm, recorded in two directions perpendicular to each other.

Fig. 4. Domain structure obtained on the thick amorphous NiCoP foil by the method of powder patterns.

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