TEMPERATURE FEATURES OF HYSTERESIS PROPERTIES OF La-Co FILMS

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Magnetic properties of La-Co films of different compositions are investigated experimentally within the temperature range of 5-350 K and interpreted with involvement of computer modeling. Exchange bias is detected, its presence is associated with amorphous-crystalline inhomogeneity of the films.

Perspective development principles of high-density magnetic systems for recording information, including MRAM [1], are oriented to planar media with out-of-plane easy magnetization axis. It causes stable research interest towards magnetic films with such type of magnetic anisotropy also known as perpendicular anisotropy. As we have shown earlier [2], films of the La-Co system with a lanthanum content up to 20 at. % demonstrate perpendicular anisotropy. This work is aimed at explaining the nature of the perpendicular component of magnetic anisotropy and consists in studying the temperature effect on the magnetic properties of La-Co films obtained by high-frequency ion sputtering.

The experiment is carried out on LaxCo100-x films of 100 nm thickness, deposited on Corning glass substrates and covered with a Ti protective layer. The composition of the films in the range of $5 < x < 25$ is determined on a Nanohunter X-ray fluorescence spectrometer, microstructure is evaluated using X-ray diffractometry, and magnetic properties are measured on a MPMS XL7 system in the temperature range of $5 \div 350$ K.

Systematic quantitative data on the structure and temperature dependencies of magnetic properties of films of different compositions are obtained from experiments. It is shown that a characteristic qualitative feature of their magnetism is the state with stripe domain pattern, which leads to a specific (beveled) hysteresis loop. An example of such loop is shown in Fig. 1,a for the La18Co82 film. Its coercivity, saturation and remanent magnetization are weakly dependent on temperature (Fig. 1, b and Fig. 1, c). At the same time, it is found that as the temperature T decreases, the shape of the loop itself is significantly distorted. It gains a multi-stage form, which can be interpreted as a superposition of two half-loops that move apart as T decreases. Generally, the temperature dependence of the bias field Hbias, which characterizes the position of the center of the half-loop in the region of positive magnetization values, is shown in Fig. 1, c.

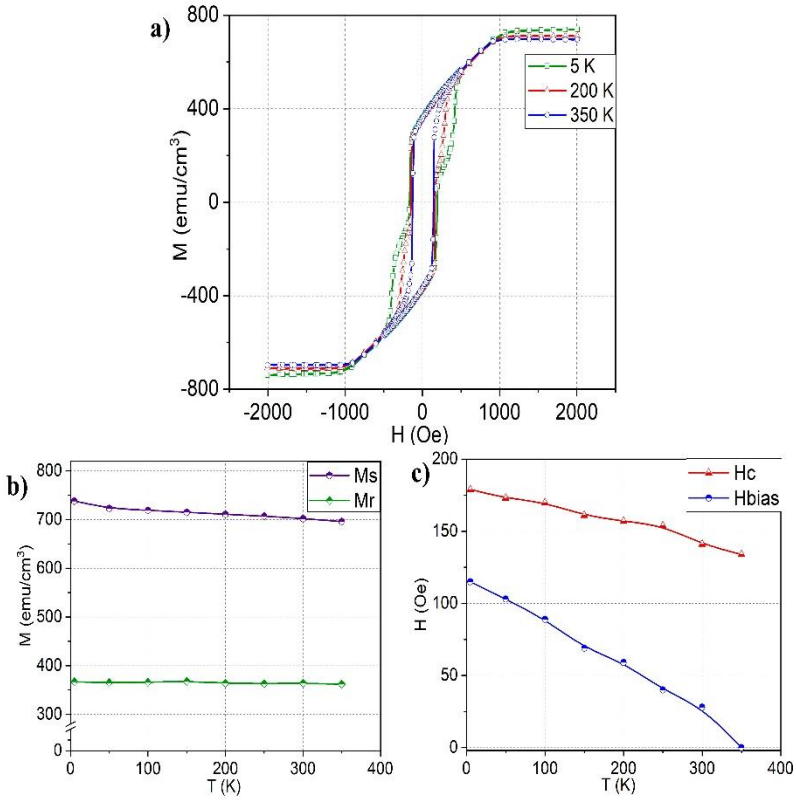

Fig. 1. Hysteresis loops at different temperatures (a) and the temperature dependences of the properties (b, c) of the $La_{18}Co_{82}$ film: Ms — saturation magnetization; Mr — remanent magnetization; H_c — coercivity field; H_{bias}– half-loop center bias field.

In work the analysis of the obtained experimental data is carried out using computer modeling. In particular, it is shown that low-temperature anomalies of hysteresis loops can be a consequence of amorphous-crystalline film inhomogeneity, leading to the coexistence of exchange-coupled ferromagnetic and antiferromagnetic phases that differ in the temperature behavior of the magnetic anisotropy parameters.

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