ABSTRACT

Ing. Mgr. Aleš Hendrych
Palacky University, Olomouc, December 2009
Supervisor: Doc. RNDr. Roman Kubínek, CSc.

Magnetic properties of the nanocomposite materials

An enormous advancement in magnetic nanomaterial research during last two decades has been achieved. Much of the effort has been paid to the fundamental physical aspects arising from the preparation process. New trends mainly in the area of information, data storage and sensor technologies are pushing up the development of new magnetic materials to nanometer dimensions. There is still a challenge to meet on the field of the nanomaterials because only in user-specific control limited success was reached so far. Many parameters that affect the final material composition including heat treatment and straining effects should be taken into account due to feasibility of tuning or perking up magnetic nanostructured materials.

Thoroughly performed scientific investigations are needed in order to successfully describe and clarify newly developed systems. Naturally, such investigations have to be realized by delicate measuring methods. Therefore, this thesis is dedicated to the development of the particular techniques, namely magneto-optical methods, magneto-optical vector magnetometry, Kerr microscopy and magnetic force microscopy, which are suitable for characterization of magnetic-based nanomaterials mainly in a form of nanocomposite films and ribbons.

The concept of the thesis is divided into two parts. The first part introduces theoretical background and its physical matter including detecting principles within the scope of measuring devices and set-ups. Operational mechanisms of the magnetic force microscopy is described in detail as well as the nature of the long-range forces acting on the probe or sample. The disposition of the probe to sample interaction and concrete detection regimes are also included. Magnetooptic aparatus is presented in the similar manner with the deep description of the magnetooptic vector magnetometry based on differential intensity method.

The whole system is used for measuring near-surface hysteresis loops in longitudinal and transversal configuration. The surface domain observation is ensured by means of the magnetooptic Kerr microscopy. The second part includes results obtained from the investigation performed on two kinds of amorphous ribbons, CoFeCrSiB and FeNbB, both prepared by planar flow casting method.

Amorphous CoFeCrSiB samples are interesting mainly due to their exhibition to the asymmetric giant magnetoimpedance (AGMI) effect, known as a promising sensor tool. We proposed the magnetooptic method, which consists in the elimination of demagnetizing events by DC current flowing through the ribbon. Consequently, the magnetic properties were evaluated on the basis of condition changes during the annealing and loading. On the contrary, the presence of crystalline phase on the surface confirmed by Mössbauer spectroscopy and X-ray diffraction suggests, that FeNbB ribbons embody interesting anisotrophy distribution and surface magnetic domain ordering. Moreover, we utilised the schematic model, that clearly describes distribution of amorphous and crystalline phases occured on both ribbon sides as well as the depth profile parameters.