XMCD study of $Sm_2Fe_{17}H_n$ and $Sm_2Fe_{17}N_x$ alloys

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X-ray magnetic circular dichroism (XMCD) measurements at Fe K- and Sm L_3- edges of Sm_2Fe_{17} compound with different degree of nitriding and hydrogenation are presented.

The XMCD studies were performed at the ID12 beamline of the European Synchrotron Radiation Facility (ESRF), Grenoble, France. The experiments were carried out on the high field XMCD end-station equipped with superconducting solenoid producing a magnetic field up to 17 T. The XMCD spectra were obtained as a direct difference between consecutive XANES recorded with opposite helicities of the incoming X-ray beam. In addition we have measured magnetic field dependence of XMCD signal of $Sm_2Fe_{17}H_n$ and $Sm_2Fe_{17}N_x$ samples in magnetic fields up/down to 17 T. For that, the energy of X-ray monochromator was tuned to the positions of the main maxima of previously recorded XMCD spectra at either Fe K or Sm L_3 absorption edges. These so-called element selective magnetization curves were compared with macroscopic one that has been measured on the same samples in a magnetic field up to 9 T using physical property measurement system (PPMS) with vibrating sample magnetometer attachment.

Based on the joint macroscopic and local studies of the magnetic and structural properties, it has been established that the interstitial phase Sm_2Fe_{17} formed as a result of hydrogenation and nitriding processes differs substantially in their nature. The $Sm_2Fe_{17}H_n$ (hR19) phase formed during the hydrogen treatment is a solid solution of hydrogen in the Sm_2Fe_{17} lattice, whereas the $Sm_2Fe_{17}N_x$ phase is an intermetallic compound. In addition, an increase in the volume of a unit cell during the formation of interstitial phases in the case of hydrogen does not lead to a change in the type of magnetocrystalline anisotropy ("easy plane"), whereas in nitrides it is transformed into an anisotropy of the "easy axis" type. The observed changes in XMCD spectra indicate a noticeable influence of nitriding on local magnetic properties of both iron and samarium sublattices, whereas hydrogenation has a little effect.

It was found that interstitial nitrogen atoms, due to the expansion of the unit cell that causes bond relaxation, have a significant effect on the Sm *5d* and Fe *4p* electronic bands. This manifests itself in a decrease in the *5d-3d* hybridization caused by lattice expansion and the covalent action of nitrogen and is consistent with the behavior of the Fe K- and Sm L_3-edge XMCD magnetization curves, indicating that nitriding, in contrast to hydrogenation, strongly reduces the magnetic moments localized on iron ions and slightly increases the magnetic moments localized on samarium ions. These facts are confirmed by observing the growth of the magnetocrystalline anisotropy of Sm_2Fe_{17} with nitriding.