Magnetism of Metal Thin Films and their Spectroscopic Characterization

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Magnetic thin films have been one of the most attractive materials in computer technology since the discovery of giant magneto-resistance (GMR, 2007 Nobel Prize in Physics) and perpendicular magnetic anisotropy (PMA) because the two functionalities match recent requirements for higher density HDD. These phenomena are also quite exciting from the view point of fundamental physics, and moreover, further exploitation of characterization techniques of magnetic thin films and nanomagnets have become indispensable. In this Lecture, after a short introduction to useful and interesting properties of magnetic thins films, I will show some spectroscopic characterization methods based on magnetic circular dichroism: Magneto-optical Kerr effect (MOKE) using visible-ultraviolet lasers and X-ray magnetic circular dichroism (XMCD) using synchrotron radiation X-rays. A recently installed superconducting magnet system for XMCD is also described [1]. As applications of MOKE and XMCD, I will first discuss on the CO-induced dramatic spin reorientation transition in Co thin films grown epitaxially on Pd(111) [2]. It is found that CO molecules adsorbed on the bridge site of the Co surface exclusively contribute to the stabilization of perpendicular magnetic anisotropy of Co. The next topic is a magnetic property of self-assembled Co nanorods grown on a N-modified Cu(110) surface [3]. It is elucidated that although magnetic rods usually shows magnetic easy axis along the rod direction, the Co nanorods exhibit a different easy axis dominated by the magneto-crystalline anisotropy. This phenomenon is discussed in terms of the microscopic spin-orbit interaction deduced by XMCD. Finally, I will talk about our recent main subject concerning the exploitation of novel magnetic nanoscope based on the ultraviolet photoemission magnetic circular dichroism (MCD) [4]. Our very recent discovery of drastic enhancement of two-photon photoemission MCD will also be discussed.

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