5-6 Microscopic Magnetization Process in a $Tb_{43}Co_{57}$ Amorphous Film Using Magnetic Compton Scattering

－New Measurement Method for Spintronics Materials－

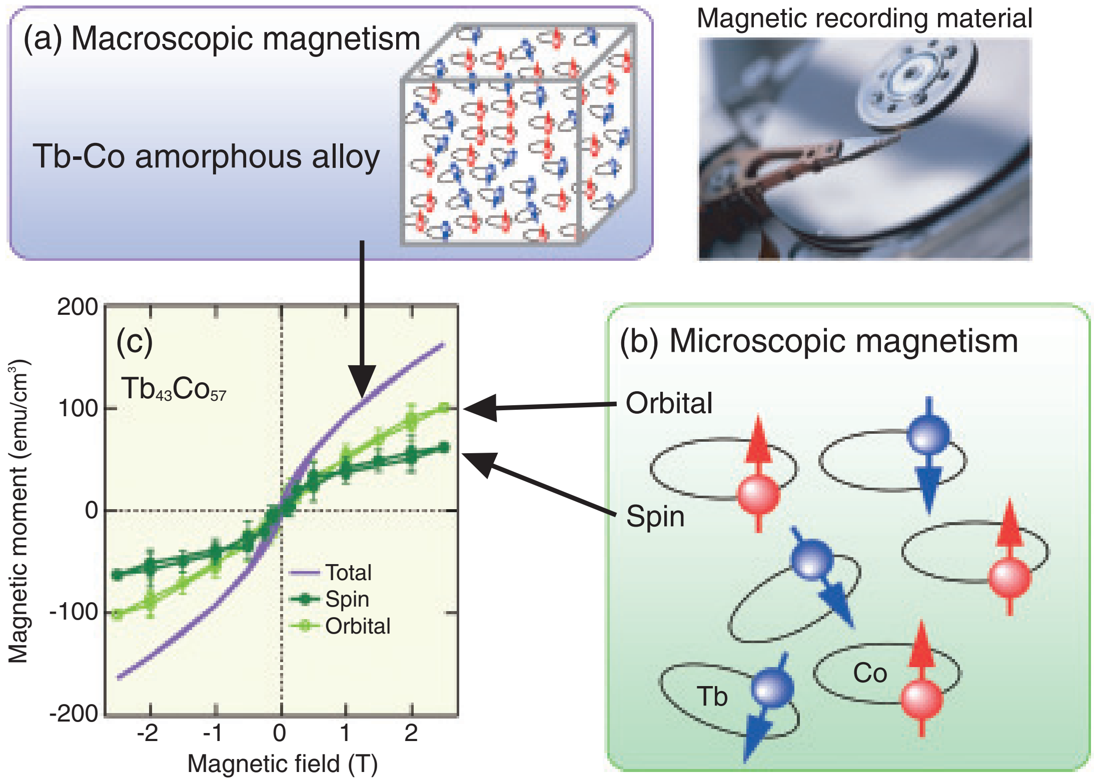

Fig.5-14 Magnetic hysteresis loops measurement
(a) Illustration of the macroscopic magnetism of an amorphous $Tb_{43}Co_{57}$ film. (b) Illustration of the microscopic magnetism of $Tb_{43}Co_{57}$. Magnetic moments of Tb and Co are oriented in anti-parallel to each other. Each magnetic moment consists of spin and orbital magnetic moments. (c) Solid curve: Macroscopic magnetic hysteresis loop measured using SQUID. Dark green circles: spin-specific magnetic hysteresis (SSMH) loop. Light green circles: orbital-specific magnetic hysteresis (OSMH) loop. The shape of the SSMH is different from that of the OSMH.

Amorphous rare earth-transition metal alloys are candidate materials for high-density recording media and spin electronic devices. Traditionally, the materials for magnetic devices are developed on the basis macroscopic magnetic property measurements, e.g., using superconducting quantum interference devices (SQUIDs) (Fig.5-14(a)). Because macroscopic properties originate in microscopic properties, such as the magnetic spin and orbital components (Fig.5-14(b)), it is also valuable to investigate the microscopic magnetic properties to design a high-performance magnetic recording material.

While the Compton profile directly corresponds to the double integral of the electron moment in materials, the magnetic Compton profile (MCP) reflects only the net spin magnetic moment of a magnetically active electron. Recently, we developed a method for measuring the spin-specific magnetic hysteresis (SSMH) loop using the magnetic field dependence of the MCP intensity.

The dark green circles in Fig.5-14 (c) show the SSMH loop of a $Tb_{43}Co_{57}$ amorphous film measured at the synchrotron radiation facility SPring-8. In addition, we obtained the orbital selective magnetic hysteresis (OSMH) loop for the first time, which is shown as light green circles in Fig.5-14(c), by combining the SSMH with the results for the macroscopic magnetic hysteresis loop. The results show that the SSMH, OSMH, and macroscopic hysteresis loops have different line shapes. The spin component is softer than the orbital component under a magnetic field, indicating that the speed of magnetic switching is different between the spin and orbital components. In addition, it was found that the contribution to the SSMH from Co was different from that from Tb.

This study demonstrates that it might be important to use separately microscopic information, i.e. the magnetic hysteresis of the spin and orbital components, to develop magnetic devices such as spin electronic devices.

Reference

Agui, A. et al., Microscopic Magnetization Process in $Tb_{43}Co_{57}$ Film by Magnetic Compton Scattering, Applied Physics Express 4, 2011, p.083002-1-083002-3.