Spin/orbital magnetization switching behaviours and electronic states of magnetic thin films

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Magnetic Compton profile (MCP) measurements, which probe spin-specific wavefunctions in momentum space, are well suited for electronic structure studies of magnetic thin films with perpendicular anisotropy (PMA), such as Co/Pd and Co/Pt multilayers. We have reported that magnetic quantum number occupancy contributes to the PMA of multilayers [1-5]. Measuring the magnetic field dependence of MCPs yields spin specific magnetic hysteresis (SSMH) curves [6], since MCPs probe spin magnetization [7-9]. Combined with magnetization measurements such as SQUID magnetometers, orbital specific magnetic hysteresis (OSMH) curves can be obtained [10,11]. By analysing the shape of the MCP, magnetic quantum number specific magnetic hysteresis curves [12-15] and element specific magnetic hysteresis curves [16-19] can be obtained.

In CoFeB/MgO multilayers, we found that the magnetization switching behaviour is different between SSMH and OSMH curves [14-15]. Although the total magnetization curve of CoFeB/MgO multilayers does not show PMA, while the OSMH curve shows step function behaviours as if it had perpendicular magnetic anisotropy. The magnetic quantum number specific magnetic hysteresis curves show that the magnetic quantum number state with $|m|=2$ corresponds to the OSMH curve. These facts suggest that the magnetization switching behaviours are governed by the orbital magnetization of the magnetic quantum number state with $|m|=2$.

TbCo amorphous thin film also showed different magnetization switching behaviour between SSMH and OSMH curves [16]. The element specific magnetic hysteresis curves showed that the magnetization of Tb corresponds to the OSMH curve.

These results suggest that magnetic field dependent measurements of MCPs can clarify the magnetic switching behaviour of magnetic thin films from the viewpoints of their electronic states.

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References