Magneto-optical detection of orbital Hall effect

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Orbital Hall effect (OHE) refers to the generation of electron orbital angular momentum flow transverse to an external electric field. Theories predict strong OHE in various transition metals of 3d, 4d, and 5d bands [1-3]. In a weak spin-orbit coupling system of 3d metals, OHE can be dominant over spin Hall effect (SHE). To detect OHE, we measured the current-driven orbital accumulation at surfaces of 3d metals of Ti, Mn, and Cu [4-6]. Using the longitudinal magneto-optical Kerr effect (MOKE), we simultaneously detected the in-plane-polarized orbital moments driven by OHE and out-of-plane-polarized orbital moments driven by Oersted field. From the relative comparison of the in-plane and out-of-plane orbital moments, we quantified the magnitude of the OHE-driven orbital accumulation. From the thickness dependence, we distinguished the bulk contribution of OHE and interfacial contribution of orbital Rashba-Edelstein effect (OREE) and determined the orbital diffusion length.

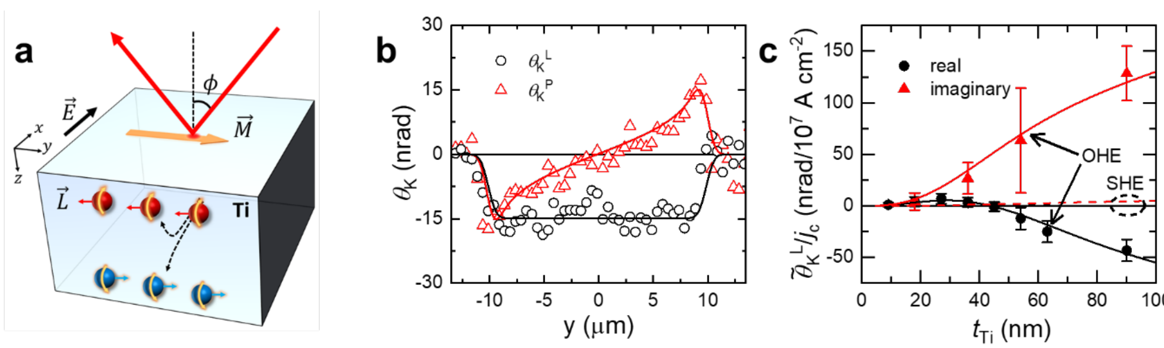

Figure 1 MOKE detection of orbital accumulation. (a) The longitudinal MOKE geometry. With an oblique incidence angle in the yz plane, MOKE can detect the y- and z-components of magnetization. (b) The measured MOKE signal on top of the Ti single layer. The longitudinal Kerr rotation comes from the OHE-driven My. The polar Kerr rotation comes from the Oersted-field-driven Mz. (c) The Ti thickness dependence of the complex Kerr rotation. The black circles and red triangles are the real and imaginary parts of the complex Kerr rotation.

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