Hybrid Spintronic Structures With Magnetic Oxides and Heusler Alloys

Hybrid spintronic structures, integrating half-metallic magnetic oxides and Heusler alloys with their predicted high spin polarization, are important for the development of second-generation spintronics with high-efficient spin injection. We have synthesized epitaxial magnetic oxide Fe3O4 on GaAs(100) and the unit cell of the Fe3O4 was found to be rotated by 45 degrees to match the gallium arsenide GaAs. The films were found to have a bulk-like moment down to 3-4 nm and a low coercivity indicating a high-quality magnetic interface. The magnetization hysteresis loops of the ultrathin films are controlled by uniaxial magnetic anisotropy. The dynamic response of the sample shows a heavily damped precessional response to the applied field pulses. In the Heusler alloy system of Co-2 MnGa on GaAs, we found that the magnetic moment was reduced for thicknesses down to 10 nm, which may account for the lower than expected spin-injection efficiency from the spin-light-emitting diode structures. Using the element-specific technique of X-ray magnetic circular dichroism (XMCD), the reduced spin moments were found to originate from the Mn rather than the Co atoms, and the improvement of the interface is thus needed to increase the spin injection efficiency in this system. Further studies of the I-V characteristics of Fe3O4/GaAs(100) and Fe3O4/MgO/GaAs(100) show that the Fe3O4-based spintronic structures have a well-defined Schottky or tunneling barrier of moderate barrier height, which is encouraging for high-efficient spin injection.

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