Enhancement of spin-orbit torques through the contribution of current-induced orbital angular momentum generated at interfaces

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The emergence of electric-field-induced orbital angular momentum (OAM) at interfaces between light elements introduces a novel mechanism for enhancing spin-orbit torques (SOTs), offering a promising alternative to traditional heavy-metal-based spintronic approaches [1-2]. Recent experimental and theoretical studies reveal that interfacial orbital textures, driven by the orbital Rashba-Edelstein effect (OREE), can generate large current-driven torques in ferromagnetic materials.

In this presentation, I will discuss recent experimental results demonstrating a substantial enhancement of damping-like and/or field-like torque component in various light element magnetic multilayers. The torque amplitudes were determined using second-harmonic Hall measurements. A first example is the Pt/Co/Al/Pt system, in which a large damping-like torque together with a giant field-like torques has been measured by second harmonic techniques. This latter, unexpected at such metallic interfaces, has been attributed to the a large Rashba effect at Co/Al interfaces [3]. First-principles and linear response theory calculations demonstrate that the Co/Al interface exhibits pronounced field-like orbital torques due to a strong Rashba texture of orbital polarization [4-5].

Another example involves Cu*/Pt/Co trilayers, where we demonstrate the interfacial generation of orbital polarization at Cu/Cu oxide interface, which, upon conversion through Pt, yield significant damping-like torques in Co [6-8]. The torque efficiency and decoherence length dependence on Co thickness further support the interfacial origin of the OAM.

These findings collectively underscore the potential of light-element interfaces in generating and controlling large SOTs through orbital-driven mechanisms, offering a pathway toward next-generation orbitronic device design.

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