Interfacing topological insulators with ferromagnets for spin-orbitronics

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Abstract

Topological insulators (TIs) enable new directions in (quantum) electronics, but their research has been mostly restricted to cryogenic temperatures that enable exploring the combinations of topology and superconductivity or intrinsic magnetism, for example. This could hinder the full realisation of the potential of TIs for novel electronics. With this in mind, the EU-funded TopRooT project (MSCA ERA Fellowship) targets the application of TIs for room-temperature electronic devices, with the objective of establishing a clear path for creating and designing such devices. To this end, a crucial technology is the integration of TIs with topologically-trivial materials, such as ferromagnets (FM), enabling applications in spin-orbitronics and other emerging magnetic X-tronics concepts. Therefore, the project focuses on optimising TI/FM heterostructures, which play a pivotal role in enabling upcoming novel technologies like SOT-MRAM. SOT-MRAM is at the forefront of the emerging technologies that enable a new generation of brain-inspired and energy-efficient computing, extremely relevant to drastically decrease the energy consumption of information and communication technologies, especially of artificial intelligence. TIs promise even higher energy efficiency than that obtained with conventional SOT materials [1].

Among the many challenges of integrating TIs with conventional ferromagnetic materials, the interface between these two materials should play a key role in determining the spin-orbit torque (SOT) effect. Therefore, this work explores different strategies to interface TIs with FMs. Bi_2Se_3 (the chosen topologically insulating system) is grown by molecular beam epitaxy and the FM layers are sputter deposited. Fabrication of test structures is achieved by photolithography and auxiliary techniques. The efficiency of the SOT in TI/FM heterostructures is accurately quantified via Harmonic Hall Voltage and spin-torque ferromagnetic resonance measurements at room temperature [2].

References

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