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Development of large-area topological insulators for spintronics

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Topological insulators (TIs) represent a state of matter in which the material bulk has insulating properties while the surface hosts highly conducting states [1]. In TIs, the presence of Dirac-like dispersed surface states jointly with the large spin–orbit coupling provides the so-called spin-momentum locking and generates topologically protected surface states [1]. Within this talk I will first present the basics of TIs with particular focus on the properties making them appealing from a technological perspective [2,3]. I will then present our strategies to develop epitaxial quality chalcogenide-based 3D-TIs over large area (up to 4") Si substrates by means of Metal Organic Chemical Vapour Deposition [4-7]. Following the validation of their topological character [7], I will present how we built simple spin-charge converters by interfacing the TIs with ferromagnetic layers (FM=Fe,Co). In such TI/FM systems, we report a large spin-charge conversion efficiency, as measured by spin pumping ferromagnetic resonance (SP-FMR) [8,9]. More recently, we developed combined Sb2Te3/Bi2Te3 heterostructures, where the top Bi2Te3 layer displays a remarkable shift of the Fermi level towards the Dirac point, as visualized by angular resolved photoemission spectroscopy [10]. This led to an almost total suppression of bulk states'contribution resulting in the emergence of ideal topologically-protected surfaces states, which are successfully exploited to enhance the spin-charge conversion efficiency when compared to single layer-TIs [10]. Our results open interesting routes toward the use of chemical methods to produce TIs over large area Si substrates, which may bring them closer to the future technology-transfer of spintronic devices based on them.

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Author: Dr MANTOVAN, Roberto (CNR-IMM Agrate Unit (IT))

Presenter: Dr MANTOVAN, Roberto (CNR-IMM Agrate Unit (IT))

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