Accepted Manuscript

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PII: S0079-6425(18)30083-5
DOI: https://doi.org/10.1016/j.pmatsci.2018.08.001
Reference: JPMS 529

To appear in: *Progress in Materials Science*

Received Date: 8 February 2018
Accepted Date: 16 August 2018

Please cite this article as: Liu, W., Wong, P.K.J., Xu, Y., Hybrid spintronic materials: Growth, structure and properties, *Progress in Materials Science* (2018), doi: https://doi.org/10.1016/j.pmatsci.2018.08.001

HYBRID SPINTRONIC MATERIALS: GROWTH, STRUCTURE AND PROPERTIES

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Abstract

Spintronics is an emergent interdisciplinary topic for the studies of spin-based, other than or in addition to charge-only-based physical phenomena. Since the discovery of giant magnetoresistance (GMR) effect in metallic multilayers, the first-generation spintronics has generated huge impact to the mass data storage industries. The second-generation spintronics, on the other hand, focuses on the integration of the magnetic and semiconductor materials and so to add new capabilities to the electronic devices. While spin phenomena have long been investigated within the context of conventional ferromagnetic materials, the study of spin generation, relaxation, and spin-orbit coupling in non-magnetic materials took off only recently with the advent of hybrid spintronics and it is here many novel materials and architectures can find their greatest potentials in both science and technology. This article reviews recent progress of the research on a selection of hybrid spintronic systems including those based on ferromagnetic metal (FM) and alloys, half-metallic materials, and two-dimensional (2D) materials. FM and alloys have spontaneous magnetization and usually high Curie temperature (T_c), half-metallic materials possess high spin polarization near the Fermi level (E_F), and the 2D materials have unique band structures such as the Fermi Dirac cone and valley degree of freedom of the charge carriers. Enormous progress has been achieved in terms of synthesising the epitaxial hybrid spintronic materials and revealing their new structures and properties emerging from the atomic dimensions and the hetero-interfaces. Apart from the group-IV, III-V, and II-VI semiconductors and their nanostructures, spin injection and detection with 2D materials such as graphene, transition-metal dichalcogenides (TMDs) and topological insulators (TIs) has become a new trend and a particularly interesting topic due to either the long spin lifetime or strong spin-orbit coupling induced spin-momentum locking, which potentially leads to dissipationless electronic transport.