Electronic properties of epitaxial graphene-Mn_5Ge_3-Ge interfaces

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Recently, much of experimental and theoretical efforts were dedicated to the investigation of the structural, electronic and transport properties of graphene-based systems, where it is interfaced with other two-dimensional materials, with metals, and with semiconducting materials, like gr/Ge(001) or gr/Ge(110) [1]. Particularly, the interfaces of graphene (and other 2D materials) with ferromagnetic (FM) materials are interesting, as in perspective they can lead to the implementation of these 2D layers in the spintronics applications as spin-filters or effective conductors for the spin-polarized electrons.

Very recently an elegant new approach for realization of the gr/FM interface with linear energy dispersion for electrons in graphene was proposed (Fig. 1) [2]. As was theoretically found, the strong exchange splitting in Mn_5Ge_3 leads to the appearance of the large exchange splitting for the graphene π bands. As a consequence of this effect, the linear dispersion is preserved for spin-up electrons that makes this gr/FM-Mn_5Ge_3 system perspective for spintronics applications.

In our recent work we study the electronic and magnetic properties of the gr/FM-Mn_5Ge_3 interfaces formed via and during intercalation of Mn in two epitaxial interfaces, gr/Ge(110) and gr/Ge(111) [3]. The protective properties of graphene allowed to perform the systematic studies of the crystallographic structure and ordering in the obtained epitaxial intercalation systems using different in situ and ex situ methods. At the same time the magnetic measurements confirm the strong FM ordering in the system with Curie temperature close to room temperature. Despite the expected small distance between graphene and FM-Mn_5Ge_3 and relatively strong interaction at the gr/FM-Mn_5Ge_3 interface in both epitaxial systems, our systematic ARPES experiments confirm E(k) dependence in the vicinity of the Fermi level for the carriers in graphene. Considering all experimental observations supported by the results of the previous DFT calculations we discuss the possible applications of the obtained gr/FM-Mn_5Ge_3/Ge heterosystems in spintronics and electronics.

References:
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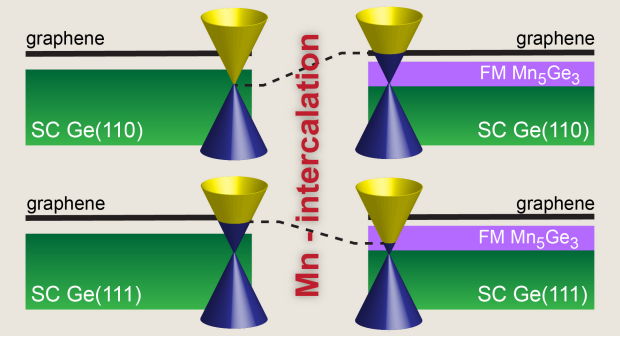

Fig. 1: Schematic presentation of the doping level change in graphene upon Mn intercalation and formation of Mn_5Ge_3 at the gr/Ge interfaces.