Heusler alloy thin films on graphene-based substrates

K. Załęski,[1] E. Coy,[1] M. Kempiński,[2] F. Stobiecki,[3] J.M. Lopes,[4] and J. Herfort[4]

[1] *NanoBioMedical Centre, Adam Mickiewicz University, Poznań, Poland*
[2] *Faculty of Physics, Adam Mickiewicz University, Poznań, Poland*
[3] *Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland*
[4] *Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany*

Spin transport in lateral spin valve (LSV) devices depends on the state of LSVs building blocks: spin injectors/detectors (ferromagnetic electrodes) and a nonmagnetic spin transport channel. Since the basic operation in spintronic devices is switching bistable nanomagnets [1] – the ferromagnetic electrodes – deployed for injection or detection of a spin-polarized current, their spin polarization at the Fermi level is crucial. The ideal candidates for spin injection/detection are half-metallic ferromagnets which exhibit 100% spin polarization of conduction electrons. Examples are some Heusler alloys: NiMnSb, Co_2FeSi, and Co_2MnSi, among others [2]. The suitable spin transport channel should allow for a long spin lifetime and long-distance spin propagation. The experimental studies of spin transport measurements identified graphene as the most favorable material for spin transport channels in spin-logic devices [3].

The properties of CVD-grown graphene on the surface of magnetron sputtered $Co_2FeGe_{0.5}Ga_{0.5}(001)$ half-metallic Heusler alloy thin film was studied by Li et al. [4]. They suggest that the electronic properties of the Heusler alloy were preserved at the interface with graphene. Yamaguchi et al. demonstrated the dry transfer of a multilayer graphene flake on the Co_2FeSi spin valve electrodes [5]. The performance of their device – large nonlocal magnetoresistance signal – was significantly large compared with previously reported values. Recently, Li et al. reported epitaxial growth of Co_2MnSi film on Ge(111) substrate via a graphene interlayer [6].

Herein, we present the influence of the properties of a graphene substrate on the growth of Heusler alloy thin films. The sputter deposited thin films of Co_2MnSn and Co_2MnAl Heusler alloys on HOPG (highly oriented pyrolytic graphite – whose surface is similar to graphene) have a polycrystalline structure. However, Co_2FeSi films grown on the same substrate have (001) texture. In the case of MBE (molecular beam epitaxy) growth of Co_2FeSi thin films on the epitaxial graphene on SiC and transferred graphene on Si/SiO_2, the morphology of the film is an island-type with (022) texture.

References:

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