Electronic and magnetic properties of graphene/$Co_2Fe(Ge_{0.5}Ga_{0.5})$ Heusler alloy heterostructure

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As a zero-gap semiconductor with a pin-hole free nature, graphene was proposed as an attractive low energy barrier for vertical spin-valves (SV) to solve the trade-off between MR ratio and low RA product usually observed in MgO-based vertical SV. So far, the MR ratio reported in graphene-spacer vertical SV is far below the application level due to the usage of conventional ferromagnetic electrodes (Ni, Co, Fe etc.) with low spin polarization. Utilizing high spin-polarized ferromagnetic electrodes such as full Heusler alloys is potential way to enhance the MR ratio in graphene-spacer SV, however, there is no precedent for success in the growth of graphene on Heusler alloy underlayer. In this study, we report on the demonstration and characterization of a novel heterostructure consisting of single-layer graphene (SLG) synthesized by high-vacuum chemical vapor deposition (CVD) on a half-metallic $Co_2Fe(Ge_{0.5}Ga_{0.5})$ (CFGG) Heusler alloy, which provides a promising building block for developing high performance graphene-spacer vertical SV.

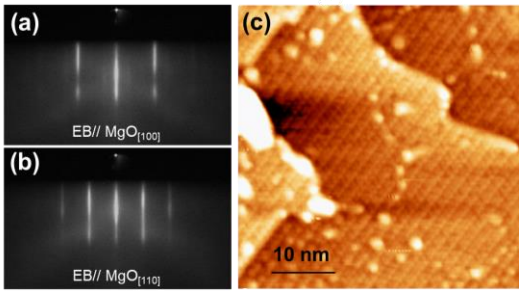

Fig. 1 RHEED (a,b) and STM (c) image of the SLG/CFGG heterostructure.

Fig. 1 shows the surface characterization results of SLG/CFGG/MgO(001) by a, b) RHEED, and c) STM. The sharp RHEED streaks indicate an atomically flap surface of CFGG at the SLG/CFGG interface. The periodic strips in the STM image is attributed to the Moire superstructure resulted from the lattice miss-match between graphene and CFGG(001), indicating the growth of single crystalline SLG on CFGG. **Fig. 2** shows the result of the depth-resolved XMCD analysis of the Co $L_{2,3}$-edge in the SLG/CFGG heterostructure. A robust magnetization was observed in the region just below the SLG/CFGG interface, which indicates little degradation of the magnetic property of the CFGG surface after the CVD-graphene growth. DFT calculations suggest that the SLG/CFGG interface has a FeGeGe-termination rather than Co-termination. The effect of SLG on the half-metallicity of the CFGG surface will be also discussed in the presentation.

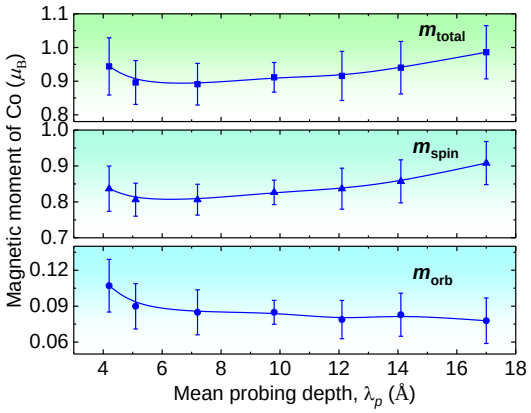

Fig. 2 Total, spin and orbital magnetic moment of Co in the SLG/CFGG heterostructure as a function of the mean probing depth from the sample surface, analyzed with depth-resolved XMCD spectroscopy.

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