スピン流の高効率制御を可能にする革新的グラフェン/ホイスラー合金ヘテロ構造の創製

A novel graphene/Heusler alloy heterostructure for advanced spintronics

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Graphene/ferromagnet heterostructures are receiving an intensive interest due to the expectation of both improving the existing storage devices and paving the way for the next generation of memory technologies with higher speed and lower power consumption. Up to now, the ferromagnets involved in the graphene/ferromagnet heterostructures are limited to the conventional magnetic materials with low spin-polarization, which corresponds for the poor performance found in those graphene/ferromagnet heterostructures based spintronic devices.

With the aim of realizing high-performance graphene-based spintronic devices, we recently developed a novel graphene/ferromagnet heterostructure which consists of a single layer graphene (SLG) on a full Heusler alloy $CoFeGe_{0.5}Ga_{0.5}$ (CFGG) ferromagnet (half-metal with high-polarization) [1]. The growth of high-quality with a full coverage of SLG on CFGG was succeeded by careful optimization of the *in-situ* chemical vapor deposition (CVD) procedure. The spin-resolved electronic properties of the interface region in the SLG/CFGG heterostructure were examined by depth-resolved x-ray magnetic circular dichroism (XMCD) spectroscopy with atomic depth resolution. It is revealed that the SLG/CFGG heterostructure shows not only a quasi-free-standing nature of SLG but also a robust magnetism comparable to that of bulk one in the atomic layer adjacent to SLG. The total-reflection high-energy positron diffraction (TRHEPD) spectroscopy measurement reveals the SLG/CFGG heterostructure has an unusual large interlayer distance comparing to other reported graphene/ferromagnet heterostructures, which leads to the preservation of the inherent electronic and magnetic properties at the SLG/CFGG interface associating with the weak van der Waals interactions at the interface. The density functional theory calculation results indicate the linear Dirac band structure of graphene and half-metallicity of CFGG in the vicinity of the interface are well preserved in the SLG/CFGG heterostructure. Our results suggest the developed graphene/CFGG heterostructure can be a very potential building block for high-performance graphene spintronic device application.

[1] S. Li *et. al*., *Adv. Mater*. **32**, 2070043 (2020)