# Unique magnetic and spintronic behaviours of various 2D atom-thin layers

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Spin-based phenomena in various Two-dimensional (2D) atom-thin layers are attracting significant attention. In the talk, first, I present magnetisms arising from edges of graphene [1], few-layer black phosphorus (BP) [2], and hexagonal boron-nitride (hBN) [3]. I create low-defect nanomesh (NM) structures, consisting of honeycomb like array of hexagonal pores, with specified pore-edge atomic structure (i.e., zigzag type) on individual layers. Interestingly, hydrogen-terminated graphene NM (H-GNM) shows flat-band ferromagnetism, while it disappears in oxygen-terminated GNM (O-GNM)[1]. On the other hand, O-BPNM exhibits huge large ferromagnetism due to ferromagnetic spin coupling of edge O-P bonds, whereas it disappears in H-BPNM[2]. O-hBNNM shows small ferromagnetism due to edge O-N bonds, while it disappears in H-hBNNM [3]. These are also highly sensitive to annealing temperatures to form zigzag pore edge. These open a considerable avenue for realizing 2D atom-thin flexible magnetic and spintronic devices, fabricated without using rare(-earth) magnetic atoms. Latest observation of edge magnetism for few-layer molybdenum disulfide ($MoS_2$) NM will be also demonstrated.

Second, I will briefly show introduction of Rashba-type spin-orbit interaction (SOI) into graphene realized by the out-of-symmetry breaking only through much light hydrogenation (<< 0.1%) using specified electron beam (EB) resist [4]. Symmetric internal-effective magnetic field of the SOI unique to graphene induces spin phase coherence in weak localization in the hydrogenated graphene. Voltage-controlled spintronics in graphene must open doors to novel physics and applications for topological insulator and computation on Majorana Fermion.

As another issue, I will also show creation of the world-thinnest Schottky junction based on semiconductor(2H)/metal(1T) transition of few-layer $MoS_2$, realized only by irradiating EB [5]. This EB top-down patterning opens the possibility to fabricate in-plane lateral heterostructure FETs and LSI circuits.

References

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