Unveiling chemisorbed crystallographically heterogeneous graphene/$L1_0$-FePd interface with robust and perpendicular orbital-moment

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Supporting Information

Surface morphology of $L1_0$-FePd and quality of graphene on $L1_0$-FePd

Atomic force microscopy (AFM), (Fig. 1S) optical microscopy, (Fig. 2S left) and Raman spectroscopy (Fig. 2S right) observations were used to investigate surface morphology. The surface of $L1_0$-FePd without graphene (Gr) layer was evaluated by AFM. Gr layer grown on $L1_0$-FePd epitaxial film was characterized by optical microscopy and Raman spectroscopy mapping. These multiple surface observations revealed that the Gr/$L1_0$-FePd has homogeneous flat surface.

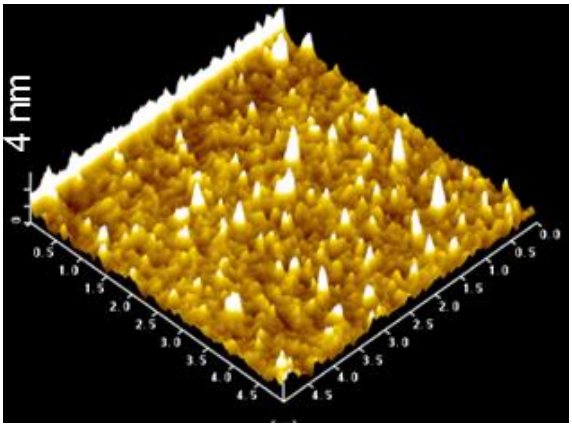

Figure S1. The surface morphology of $L1_0$-FePd film was evaluated by atomic forced microscopy (AFM, Oxford Instruments Cypher).

The AMF image is only FePd and Gr was not deposited yet. Then, the epitaxial $L1_0$-FePd film was grew on $SrTiO_3$ (100) substrate and the AMF observation was carried out as soon as possible after growth of FePd to prevent the influence of surface oxidation. The tip with Pt/Ir coating on Si was used as cantilever. The signal was increased by driving at a resonance frequency of about 80 kHz. The area of 5μm square was evaluated at five different points, and the average roughness was deduced. The surface flatness of R_a was 0.36 nm. This flat surface of $L1_0$-FePd can be used as a bottom ferromagnetic electrode of magnetic tunnel junctions (MTJs).

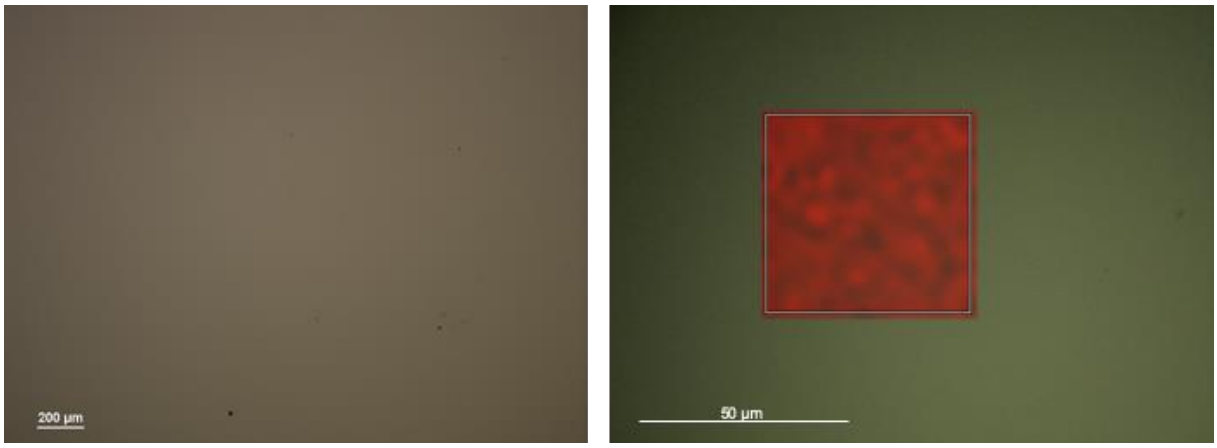

Figure S2. (left) Optical images taken after graphene (Gr) growth on $L1_0$-FePd surface and (right) superimposed Raman mapping of the graphene *G* peak signature (right inset). The optical microscopy and Raman spectroscopy observations we used in this study was Renishaw Raman InVia microscope, 532 nm excitation.

The optical microscopy image indicated the homogeneous contrast, and the pinhole was not confirmed in the wide area. The Raman spectroscopy was measured by *G* peak nature. It was confirmed that the graphene was coved homogamically on the $L1_0$-FePd layer. This homogeneous graphene on the $L1_0$-FePd was as same as those of graphene on Cu and Ni.[1)]

Reference for supporting information

1. R. S. Weatherup, B. Dlubak, and S. Hofmann. Kinetic Control of Catalytic CVD for High-Quality Graphene at Low Temperatures, ACS Nano, **2012**, *6*, 9996-10003.