2020「中技社科技獎學金」

2020 CTCI Foundation Science and Technology Scholarship

境外生研究獎學金

Research Scholarship for International Graduate Students

鈷鈀合金在二維材料上的磁性特性

Magnetism of CoPd on two-dimension material

國立臺灣師範大學 物理系

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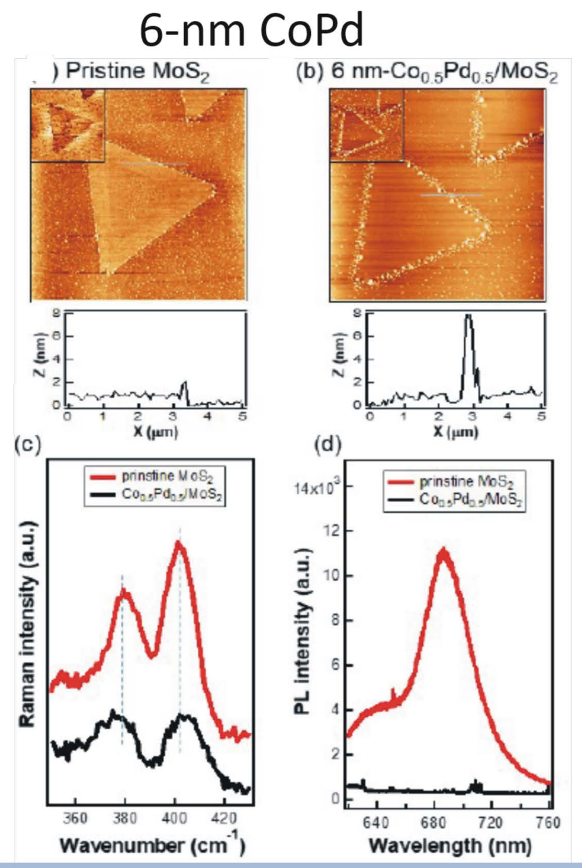
研究重點

First part, CoPd alloy nanostructures and thin films were deposited on MoS2 flakes through e-beam evaporation at a high temperature (HT) (500 K) and at room temperature (RT) (300 K). In HT growth, CoPd nanoparticles assembled at the edge of the MoS2 flake. As indicated by the quenched photoluminescence, HT deposition resulted in a flat CoPd coverage with a roughness of ±0.5 nm on a MoS2 terrace. By contrast, RT growth led to a relatively rough CoPd thin film on MoS2 (roughness ±2 nm). The film comprised a merged nanoparticle assembly. The MoS2/SiO2 step edge played a crucial role in magnetic domain pinning such that the magnetic coercivity (Hc) of Pd/Co/MoS2 was smaller than that of Pd/Co/SiO2. Similarly, RT CoPd (8 nm)/MoS2 exhibited a parallelogram-shaped hysteresis loop with a relatively small Hc value compared with that of the square hysteresis loops of RT CoPd (8 nm)/SiO2. Second part, we propose a new method to fabricate micro-structured magnetic domains using patterned single-layer Gr. In the first experiment, single-layer Gr was transferred onto a CoPd alloy film pre-grown on a SiO2/Si(001) substrate. Subsequently, the single-layer Gr was patterned through electron beam lithography followed by oxygen plasma etching to expose selective micron-sized areas of CoPd. The exposed areas of CoPd were more easily oxidized compared to the areas protected by Gr. In the second experiment, a lithographically-patterned Gr layer was placed between the Fe and CoPd films to block interlayer diffusion area-selectively during sample annealing, and magnetic contrast was observed to be established between the Pd/Fe/Gr/CoPd and Pd/Fe/CoPd areas, leading to a magnetic structure that matched the Gr patterning. These observations demonstrate that Gr patterning is a simple and powerful method of fabricating spintronic devices.

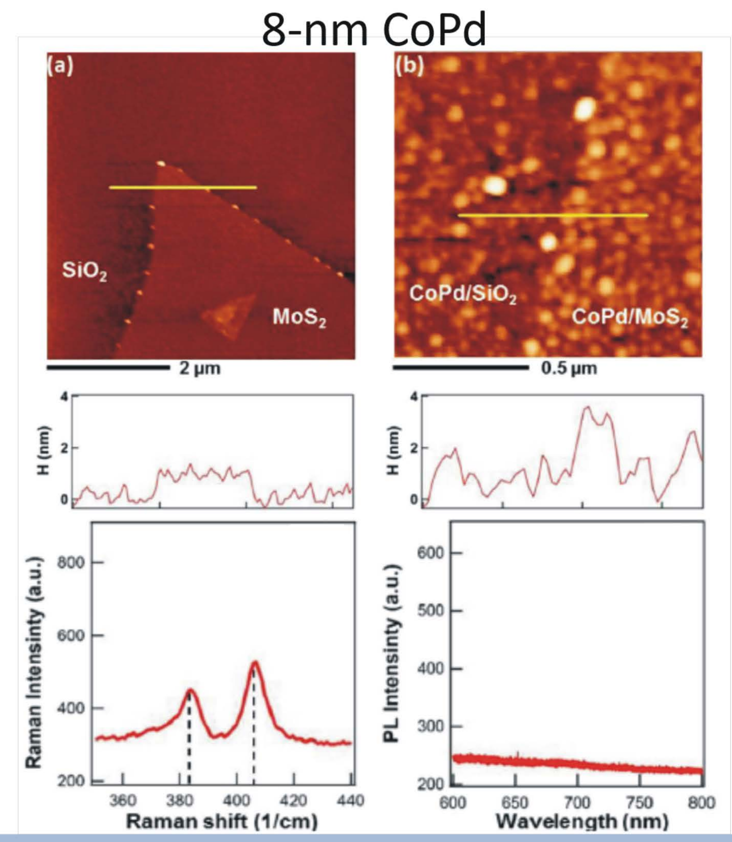
研究結果

Morphology of room-temperature(RT) deposition and high-temperature(HT) deposition CoPd/MoS_2

(a) Characterization of HT -deposited 6-nm CoPd

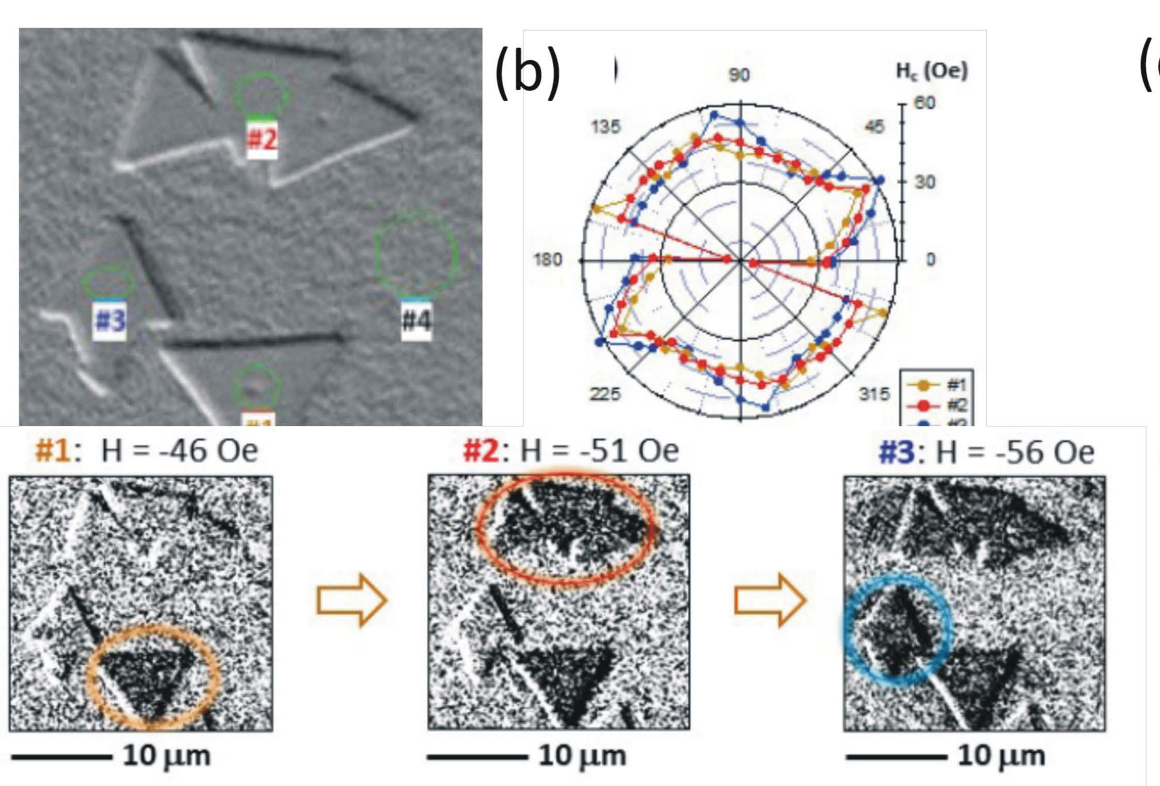


(b) Characterization of RT -deposited 8-nm CoPd



(a) The HT deposition of CoPd on the MoS_2 surface resulted in a at and uniform coverage with a roughness less than 1nm. The cluster nucleation at the MoS_2 edge as previously reported, the topography on the MoS_2 terrace remained at and the roughness was within 1 nm.
(b) After deposition of 8-nm Co-Pd at RT, the MoS_2-SiO_2 step became indistinct and the MoS_2 surface comprised CoPd nanoparticles with a size of approximately tens of nano-meters. because the surface energy of the deposit is higher than that of the substrate, and the interaction between the deposit and substrate is weak.

Magnetism of room-temperature(RT) deposition and high-temperature(HT) deposition CoPd/MoS_2



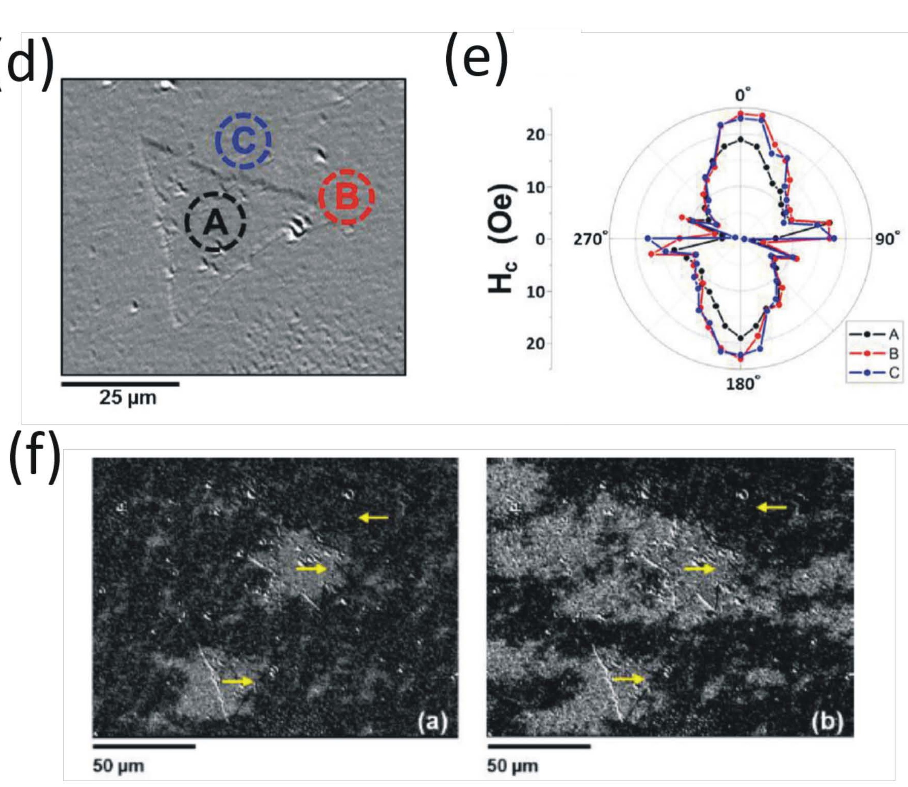
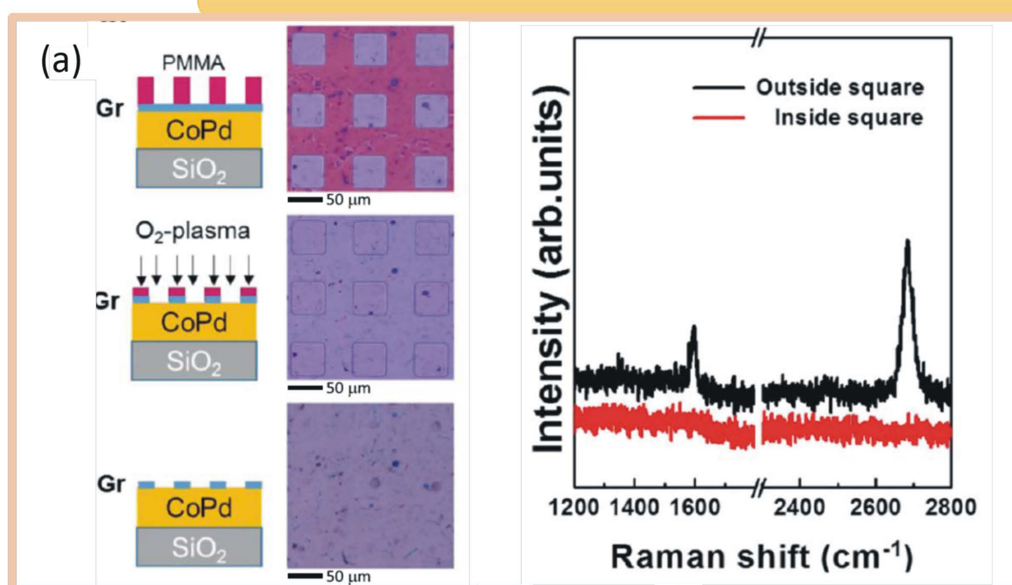
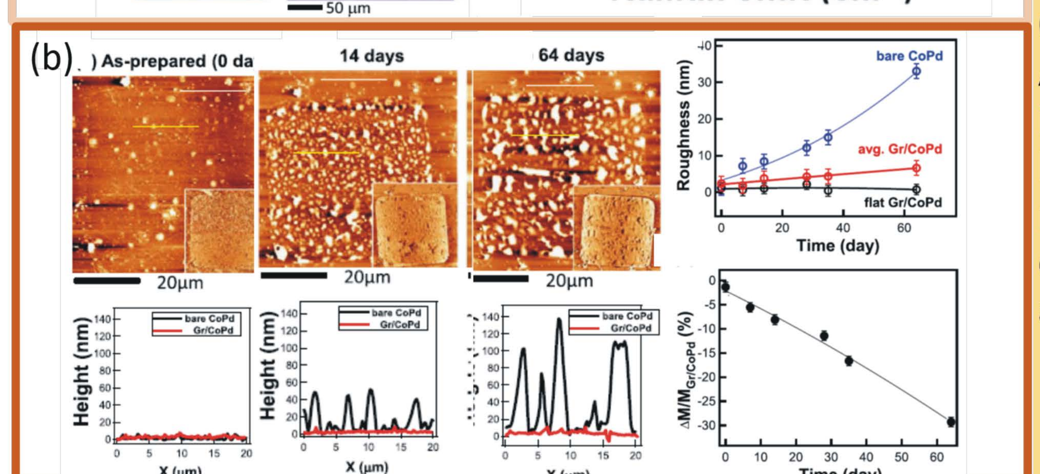


Figure left is shows an ψ –dependent azimuthal angle related to in-plane magnetic behaviour of the HT-grown 6-nm CoPd/MoS_2 fakes. As indicated in the optical image of Fig. (a), three CoPd/MoS_2 fakes (#1-#3) and CoPd/SiO_2 (#4) were selected for analysis. Fig. (b) shows the magnetic hysteresis loops measured at ψ = 90 from the four individual areas #1-#4. In Fig. (c), a series of Kerr images recorded at sequential magnetic field exhibit the magnetic switching sequence of the CoPd/MoS_2 flakes.
Figure right is shows the azimuthal angle (4)-dependent magnetic properties of 2nm Pd/7nm Co/MoS_2 were analyzed . Fig. (e) illustrates the polar plot of the magnetic coercivity (H_c) as a function of ψ. In Fig.(f), The magnetic domain reversal at 0.9 H_c and H_c were observed using the magneto-optical Kerr microscope to determine the physical origin of the H_c change.

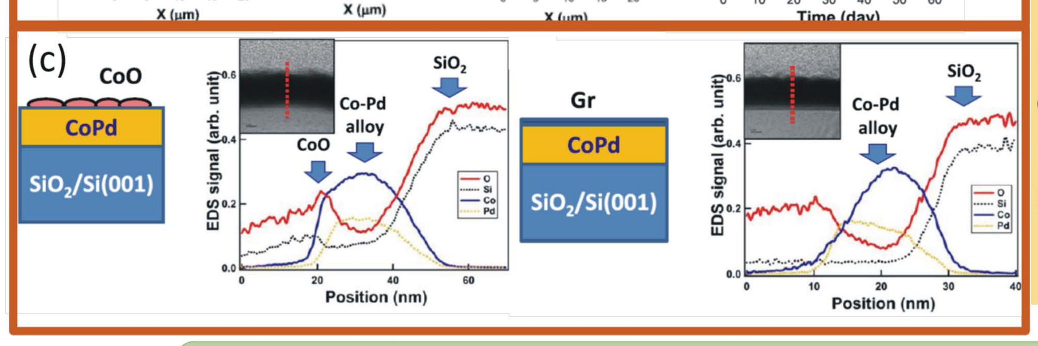
Graphene protection against oxidation



(a) The single-layer Gr was patterned through electron beam lithography followed by oxygen plasma etching to expose selective micron-sized areas of CoPd.

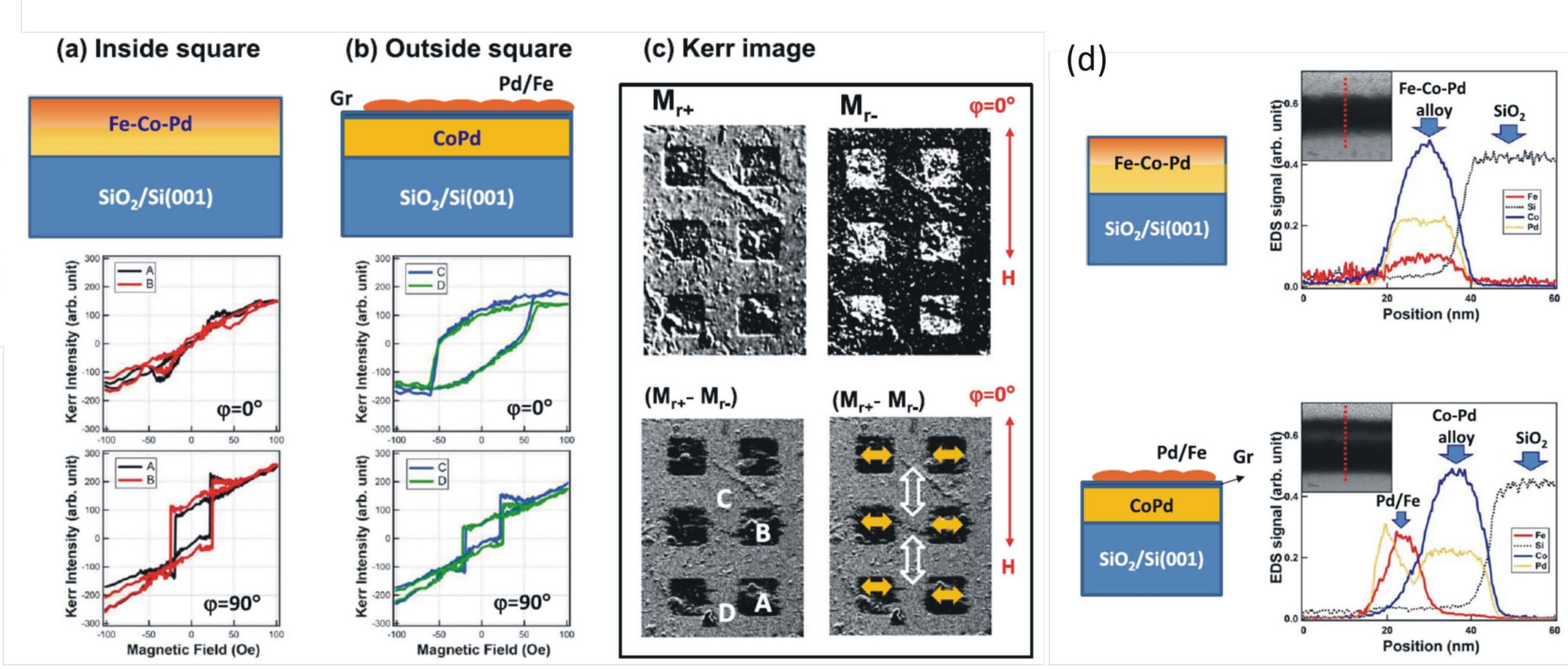


(b) shows the change in the surface morphology of the patterned-Gr/CoPd sample under ambient conditions for 0–64 day after fabrication.
Also Evolution of the difference in the Kerr intensity between the bare CoPd and Gr/CoPd areas normalized by the Kerr intensity of Gr/CoPd as a function of the ambient exposure time.



(c) TEM cross-sectional EDS depth profiles and elemental mapping for (a) bare CoPd and (b) Gr/CoPd areas.

Graphene protection against interlayer diffusion



Magneto-optical Kerr hysteresis loops measured from (a) Pd/Fe/CoPd and (b) Pd/Fe/Gr/CoPd areas of the annealed sample. The measurements were performed with an in-plane magnetic at azimuthal angles ψ=0° and 90°, respectively. (c) Kerr remanence images of the annealed Pd/Fe/patterned-Gr/CoPd sample at ψ =0°. Mr_+ and Mr_- are the remanent states after magnetic saturation in the positive and negative directions, respectively. The red arrows indicate the direction of the magnetic field H_c. The magnetization directions of the individual areas are indicated in the (Mr_+−Mr_-) images in the lower panel.
(d) EM cross-sectional EDS depth profiles and elemental mapping for Pd/Fe/CoPd and Pd/Fe/Gr/CoPd areas annealedat 300 °C.

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