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**【Department Spotlight】Prof. Hung-Chung Hsueh and Chih-En Hsu Collaborate with NCKU, NTU, NSRRC to Pioneer 2D Ferroelectric Material, Reaching International Journals**

**Campus focus**

Professor Hung-Chung Hsueh, Dean of Research and Development and faculty member of the Department of Physics, along with Chih-En Hsu, a third-year Ph.D. student in Applied Sciences, collaborated with research teams from National Cheng Kung University (NCKU), the National Synchrotron Radiation Research Center (NSRRC), and the Center for Condensed Matter Sciences at National Taiwan University (NTU) to publish the paper titled “Epitaxial Ferroelectric Hexagonal Boron Nitride Grown on Graphene” in the April issue of the prestigious international journal Advanced Materials, which holds an impact factor of 27.4 and a five-year impact factor of 30.2.

The team’s research marks the first successful demonstration of epitaxially stacking ultrathin ferroelectric hexagonal boron nitride (h-BN) films on graphene, proving their ability to switch electric polarization stably. The findings show that the moire superlattice formed at the h-BN/graphene heterointerface induces spontaneous polarization, and interlayer sliding enables reversible switching, confirming the material's ferroelectric properties. Ferroelectricity, which refers to the ability of a material to switch electric polarization direction like an internal electric switch, is particularly well-suited for memory devices, sensors, and low-power computing technologies.

According to Hsueh, Professor Chung-Lin Wu’s team at NCKU used plasma-assisted molecular beam epitaxy (MBE) to grow high-quality single-crystal graphene on a silicon carbide substrate, then precisely layered h-BN atop it. The naturally formed moiré pattern at the interface induces a polar structure with asymmetry that can be switched via an electric field. NSRRC researcher Cheng-Maw Cheng explained that the team utilized Taiwan Light Source (TLS) at NSRRC to perform angle-resolved photoemission spectroscopy (ARPES) measurements, clearly observing band structure variations in h-BN/graphene heterostructures across different h-BN layer counts. Hsueh and Hsu used first-principles calculations, including density functional theory (DFT) for ground-state and GW many-body perturbation theory for excited-state simulations, to validate the interlayer polarization mechanism and identify the presence and characteristics of the asymmetric ferroelectric stacking structure.

This breakthrough offers a new opportunity for heteroepitaxial growth of 2D ferroelectric materials and developing tunable electronic components. It also lays the groundwork for future innovations in Taiwan’s semiconductor and optoelectronic industries by designing vertically stacked heterostructure chips. Prof. Hsueh stated that through this collaboration with the research teams from NCKU, NSRRC, and NTU, the Department of Physics at Tamkang University has demonstrated its ability to integrate theoretical and experimental research while providing students with opportunities to participate in cutting-edge international research.





