Talk

Special Condensed Matter Seminar: Heterostructures of Low-Dimensional Materials: Synthesis, Properties, and Device Applications

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Nanomaterials possess unique characteristics that distinguish them from their bulk counterparts. An intriguing example is the case of 2D transition metal dichalcogenides (TMDs) such as MoS2, which undergo a transition from an indirect to a direct bandgap material when reduced to a monolayer thickness. These 2D materials interact through van der Waals forces in the out-of-plane direction, enabling the easy formation of heterostructures by simply stacking them onto various materials.By carefully fabricating the right heterostructures, we can harness their synergistic effects to fabricate innovative functional devices. In this study, we specifically focused on utilizing lead halide perovskites as the material of choice for creating heterostructures with 2D materials due to their remarkable optical properties, including a high absorption coefficient, long diffusion lengths, and direct bandgap nature.To begin, we will discuss the novel growth techniques we developed for synthesizing different TMDs and low-dimensional perovskites. The as-grown TMD monolayers exhibited excellent optical and electrical properties comparable to those of exfoliated samples. By employing a novel growth promoter, we achieved conformal growth of TMDs, and we investigated the impact of strain on their electrical and optical properties. This will be followed by the synthesis of CsPbBr3 nanoplatelets. However, fabricating devices on low-dimensional perovskites presented a challenge due to their water-soluble nature. To overcome this hurdle, we devised a novel technique to fabricate high-quality devices on water-soluble materials, thus enabling us to explore the optical and electrical properties of perovskite nanoplatelets. Remarkably, the CsPbBr3 devices exhibited very low dark current at room temperature and demonstrated ferroelectric behavior.Building upon these advancements, we combined the two materials, TMDs, and perovskites, to create heterostructures for the development of functional devices such as photodiodes and LEDs. By leveraging the complementary properties of these materials, we achieved promising results in terms of device performance. In conclusion, we will discuss the future challenges and prospects associated with the utilization of heterostructures composed of low-dimensional materials, shedding light on potential avenues for further research and development.

Monday, July 3, 2023 11:00am - 12:00pm

Foyer seminar room Ground floor / Office Bldg West

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