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Low Dimensional III-V and II-VI Semiconductors

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Semiconductor materials have tunable electrical and optical properties depending on their structure, morphology, and composition. This tunability makes them building blocks of devices used in various applications including photonics, solar cells, energy storage, and quantum computing. In this presentation, I will talk about the challenges and perspectives in nanowire growth, how we tailor their properties and characterize their structures by using electron microscopy and spectroscopy techniques. I will present two exemplary material platforms: epitaxial III-V nanowires (NWs) and solution-processed II-VI nanoplatelets (NPLs).

NWs are filamentary crystals, and they can be obtained in a self-assembled or organized manner [1]. First, I will give two examples of the heterostructures with GaAs NWs: free-standing GaAs-GaAsN core-shell NWs and in-plane InGaAs NWs, the latter of which can be organized individually or in networks across the substrate, giving us the freedom to design NW networks for quantum transport and photodetector applications [2]-[4]. The effect of strain on the properties of both kinds of NW systems can be monitored with transmission electron microscopy (TEM), cathodoluminescence (CL), and photoluminescence (PL) spectroscopy. Finally, I will address II-VI semiconductor nanoplatelets (NPLs) produced by wet chemistry. Compared to growing directly on substrates, these self-standing CdSe nanocrystals are synthesized in solution at relatively low temperatures. They are a few ML thick, and the exciton is extremely confined in the thickness direction. Additionally, by growing different materials along the lateral direction (core/crown heterostructures) and tuning the composition, the optical response of the system including emission wavelength, PL-lifetime, and quantum yield changes [5].

Our experiments are crucial for understanding the physical properties of these materials, which will ultimately lead to the utilization of these nanostructures in real-life applications.

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