# Scalable and Controllable Phase/Structure-Engineered Two-Dimensional Layered Hybrid Films Toward Functional Devices

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Novel condensed matter systems can be understood as new compositions of elements or old materials in new forms. According to the definition, various new condensed matter systems have been developed or are under development in recent years. 2D layered materials, including graphene and transition metal dichalcogenides (TMDs) allow the scaling down to atomically thin thicknesses and possess unique physical properties under dimensionality confinement. The chemical vapor deposition (CVD) process is the most popular approach for all kinds of 2D materials due to its high yield and quality. Nevertheless, the need for high temperature and the relatively long process time within each cycle hinders commercial development in terms of production cost. However, the transfer procedure has become one of the major limitations of the overall performance. In my talk, an inductively coupled plasma (ICP) was used to synthesize Transition Metal Dichalcogenides (TMDs) through a plasma-assisted selenization process of metal oxide ($MO_x$) at a low temperature. Compared to other CVD processes, ICP facilitates the decomposition of the precursors at lower temperatures. We create the phase/structure-engineered-1T/2H 3D-hierarchical 2D materials derived from the MOx 3D-hierarchical nanostructures through a low-temperature plasma-assisted selenization process with controlled shapes grown by a glancing angle deposition system (GLAD). The applications, including (1) water splitting, (2) gas sensors, (3) batteries, and (4) resistive change memory, will be reported.