Materials Day 2023 Poster Abstract

Synthesis and Properties of 2D Semiconductors

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Among the class of 2D materials, transition metal dichalcogenides (TMDs) are of interest for next generation electronic and optoelectronic applications. However, we must first elucidate how the properties and performance of the material change as a function of synthesis and device processing parameters. Here, we will highlight the successful growth and doping of various TMDs using a variety of industrially relevant synthetic techniques and elucidate how the properties of the material change as a function of processing conditions. We report both layer control synthesis of MoS_2 and phase control synthesis of $MoTe_2$ by means of tuning of precursor flow and time. We report the synthesis of WSe_2 using two metal organic precursors and study how the precursor chemistries affect the properties of the resulting material. Beyond synthesis, we will also discuss carrier doping of MoS_2 with rhenium, vanadium, and cerium that enables tunability of the electronic and magnetic properties at the atomic scale. For example, rhenium doping of MoS_2 leads to a substantial reduction of defects in the material, developing a powerful route to improve the quality of a material that is inherently defective. Finally, we will highlight breakthroughs in the synthesis and integration of ultra-low k amorphous boron nitride with a range of 2D and 3D materials via atomic layer deposition (ALD) to enable improved device performance beyond traditional dielectric systems.