**Emergent Two-Dimensional Semiconductors**

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Two-dimensional (2D) ferroelectrics has attracted interests recently for nonvolatile memory applications and can be used to construct ferroelectric Schottky diode or ferroelectric tunneling diode, with promise of fast switching speed, high on-off ratio and non-destructive readout. We have developed Molecular Beam Epitaxy (MBE) and Chemical Vapor Deposition (CVD) for the growth of high-quality, wafer-scale ultrathin films of ferroelectric semiconductors. These include for example indium selenide (In2Se3), which has modest band gap and robust ferroelectric properties stabilized by dipole-locking, as well as SnS and other novel compounds. Polarization-modulated Schottky barriers on In2Se3 exhibits giant electroresistance ratio of 3.9 × 106, with readout current density of >12 A/cm2, which is more than 200% higher than the state-of-the-art. However, the growth of pure phase In2Se3 is challenged by polymorphism and variable stoichiometry. The presence of α, β and γ phases makes phase engineering of the material highly challenging because mixed phases may co-exist during growth, or un-intended phase conversion may occur during high temperature annealing. The microscopic origin of ferroelectricity in both α and β phases, in terms of the displacement of atoms and switching of mesoscale polarization domains, is not well understood. To address these questions, we performed scanning tunneling microscopy on ex-situ as well as in-situ grown α-In2Se3 and studied voltage-induced domain dynamics during α-to-β phase transition. I will also report on our recent strategies to grow large area SnS films, and the evaluation of these films for analogue memory applications, where nanosecond switching response can be attained.

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References

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