Emergence of Polar Order in WO_3 Thin Films

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Ferroelectricity is the spontaneous ordering of electric dipoles that can be reversed by an electric field. This switchable order makes ferroelectric films natural candidates for energy-efficient electronics and motivates their exploration at the nanoscale. At reduced dimensions, elastic and electrostatic boundary conditions at interfaces play an increasingly important role in setting the polarization. In classical perovskite ferroelectrics, polarization is commonly suppressed as thickness is reduced. In contrast, binary oxide fluorite ferroelectrics are non-polar in bulk, but become polar at the nanoscale. This comparison highlights that size effects are not merely a limitation, but can also become a design opportunity.

I will focus on tungsten trioxide, which brings together aspects of both material classes. As a perovskite binary oxide, WO_3 offers a system in which polar order can be promoted through epitaxial strain. We report the deposition of epitaxial WO_3 films at temperatures below 400 °C using atmospheric-pressure spatial chemical vapour deposition. In these films, strain imposed by the substrate promotes the formation of the bulk low-temperature polar phase at room temperature. Evidence comes from x-ray diffraction, scanning transmission electron microscopy, piezoresponse force microscopy, and Raman spectroscopy. Exploring ferroelectricity in ultrathin WO_3 films could provide a new platform for polarization-controlled electronic and optical applications at the nanoscale.