Freeing wafer-scale stacking of single crystals from the shackles of epitaxial constraints

Complex oxides offer a wide range of phenomenal electrical and magnetic properties when prepared as high-quality single crystals, but integrating oxides into stacks to realize new device concepts is severely limited by constrains on structure and chemistry. Through the use of “remote epitaxy”—where graphene separates a growing oxide thin film from its substrate—superb crystallinity is achieved together with the ability to peel off oxide layers and create stacks of multiple high-quality layers assembled in a user-defined sequence. The approach heralds a new platform for the limitless stacking of any material into any heterostructure. Previously impossible combinations have been demonstrated that involve the stacking of structurally and chemically incompatible piezoelectrics and magnetostrictive oxides to make new composite multiferroics; oxides have been stacked with 2D materials to tune the properties of the 2D materials.