Sliding ferroelectricity in bulk misfit layer compound $(PbS)_{1.18}VS_2$

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The recent theoretical prediction [1] and experimental confirmation of sliding ferroelectricity has significantly expanded the group of two-dimensional (2D) ferroelectrics. Due to the weak van der Waals interactions in layered van der Waals multilayers, an out-of-plane polarization can be created in many of those systems via in-plane interlayer sliding of a layer and thereby breaking the inversion symmetry.

Although the most common bulk phase of 'perfect' TMD crystals is the centrosymmetric 2H-form, the presence of sliding ferroelectricty should not be limited to manually stacked 2D few-layer crystals. As was recently shown for the amphidynamic crystal (15-crown-5)Cd_3Cl_6 [4], sliding ferroelectricity can also be observed in bulk crystals, as long as there is no inversion symmetry between the layers in van der Waals materials.

Here, the sliding ferroelectric properties of bulk $(PbS)_{1.18}VS_2$ misfit layer compound (MLC) crystals have been investigated. MLCs are thermodynamically stable, bulk, materials with a natural superlattice, consisting of the alternating stacking of two different 2D layers, here PbS and VS_2. The superlattice's formation and stability are still under debate, but it is suggested that charge transfer between the individual layers creating a strong electrostatic bond might stabilize these compounds

Using single crystal X-ray diffraction and a combination of imaging techniques, the sliding ferroelectric properties of $(PbS)_{1.18}VS_2$ were explored. The interaction between the two subsystems is derived from the presence of satellite reflections in the diffraction pattern of the composite. We find that the subtle interaction between the two subsystems causes the presence of twins, where two of the majority twins have a twist angle below one degree, the the necessary condition for sliding ferroelectricity The presence of ferroelectric domains, with a triangular shape and size from tens of nanometers to tens of micrometres, and their surface electrical potential from the induced sliding ferroelectricity can be observed using scanning electron microscopy, photoemission electron microscopy, imaging x-ray photoelectron spectroscopy and scanning probe microscopy imaging.

References

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