$CuInP_2S_6$- sluoksninis feroelektrikas kambario temperatūroje

$CuInP_2S_6$- Room Temperature Layered Ferroelectric

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So far the realization of ultrathin ferroic materials has been limited by instability of remnant polarization in 2D structures. At the same time, integration of ferroelectric and 2D electronic functions, as well as ultimate size effects presently faces a challenge of defect-free surfaces and interfaces. Currently most ferroics are 3D crystalline materials, these surfaces have dangling bonds and rich intrinsic and extrinsic defect chemistry impeding the control and coupling across interfaces. An effective solution would be a van-der-Waals crystal with ferroic properties, where the surface energy is drastically reduced and there exists a clear pathway to a 2D material through a simple preparation method such as exfoliation.

Here, we explore the ferroelectric properties of copper indium thiophosphate, $CuIn_{III}P_2X_6$, and expound on size effects and presently achievable limits of ferroelectric phase stability. We explore ferroelectric properties of cleaved 2-D flakes of copper indium thiophosphate, $CuInP_2S_6$ (CITP), and probe size effects along with limits of ferroelectric phase stability, by ambient and Ultra High Vacuum Scanning Probe Microscopy. CITP belongs to the only material family known to display ferroelectric polarization in a van-der-Waals, layered crystal at room temperature and above. Our measurements directly reveal stable, ferroelectric polarization as evidenced by domain structures (Fig. 1), switchable polarization, and hysteresis loops. We found that at room temperature the domain structure of flakes thicker than 100 nm is similar to the cleaved bulk surfaces, whereas below 50 nm polarization disappears. We ascribe this behavior to a well-known instability of polarization due to depolarization field. Furthermore, polarization switching at high bias is also associated with ionic mobility, as evidenced both by macroscopic measurements and by formation of surface damage under the tip at a bias of 4 V - likely due to copper reduction. Mobile Cu ions may therefore also contribute to internal screening mechanisms. The existence of stable polarization in a van-der-Waals crystal naturally points toward new strategies for ultimate scaling of polar materials, quasi-2D and single-layer materials with advanced and non-linear dielectric properties that are presently not found in any members of the growing "graphene family."

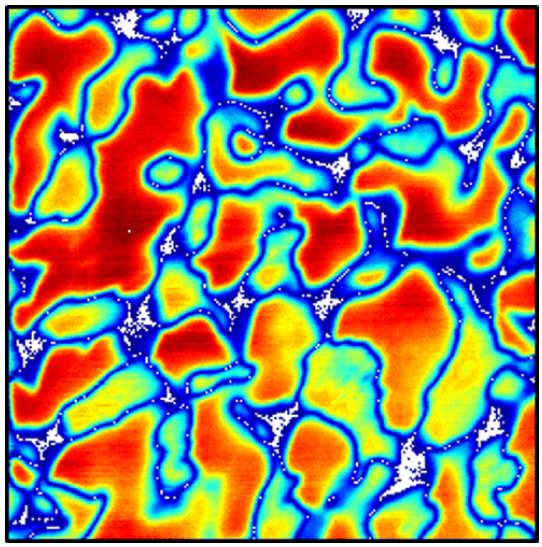

Fig. 1 Ambient Band Excitation PFM, 5x5um

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