Observation, Injection and Controlled Motion of Conducting Domain Walls in Improper Ferroelectric Cu-Cl Boracite

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Ferroelectric domain walls constitute a completely new class of sheet-like functional material. Moreover, since domain walls are generally writable, erasable, and mobile, they could be useful in functionally agile devices: for example, creating and moving conducting walls could make or break electrical connections in new forms of reconfigurable nanocircuitry. However, significant challenges exist: site-specific injection and annihilation of planar walls, which show robust conductivity, has not been easy to achieve. Here, we report the observation, mechanical writing and controlled movement of charged conducting domain walls in the improper ferroelectric $Cu_3B_7O_{13}Cl$. Walls are straight, tens of microns long, and exist as a consequence of elastic compatibility conditions between specific domain pairs. We show that site-specific injection of conducting walls of up to hundreds of microns in length can be achieved through locally applied point-stress and, once created, that they can be moved and repositioned using applied electric fields, an important requirement for conventional voltage operated devices. The discussed approaches for domain wall injection may also be useful in the design of piezoresistive-type devices, where functionality is derived from stress-induced conducting domain walls.