In situ transmission electron microscopy of domain switching in ferroelectric films

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Ferroelectrics form a class of materials with uses ranging from micromechanical actuators, infrared sensors, capacitors and non-volatile memories, amongst others. An important phenomenon in ferroelectrics is the presence of domain walls that can alter the bulk functional properties, such as conduction. More fundamentally, domain walls allow the encoding of multiple polarisation states within one device.

It has already been seen in memory devices that domain walls between opposite polarisation states are not always sharp, direct 180° transitions. Instead, polarisation curling, flux closures or vortices may be observed [1, 2]. However, previous studies have only been performed on devices in a fixed polarisation state, whereas any functional memory device requires the ability to manipulate the polarisation with an electric field. It is then unclear exactly how the domain walls and complex polarisation structures change and affect the domain switching as an electric field is applied.

Using electron microscopy, it is possible to visualise the polarisation in ferroelectric perovskites through the associated change in structure. Dark field transmission electron microscopy (TEM) can be used to show structural change on a large scale and atomic resolution (scanning) TEM can expose the local unit cell level polarisation [3]. In combination with a state of the art in situ specimen holder, here the initial results of exploration into the switching dynamics of local ferroelectricity are presented.

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