Engineering ferroelectric vortex- and stripe-like domains in polycrystalline ceramic $ErMnO_3$

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Ferroelectric materials are the backbone of many electronic components, finding applications as capacitors, energy harvesters, and actuators. The functionality and physical properties of ferroelectric materials are intimately coupled to their ceramic micro and domain structure. [1] Recently, dislocations or precipitates have been identified as an effective mean to control the domain pattern in ferroelectrics. [2] In addition, more complex topological structures have drawn interest, giving a new dimension to the control of ferroelectric domains and their responses.

Here, we use piezoresponse force microscopy (PFM), to explore domain engineering via topologically protected vortex/anti-vortex cores and microstructural degrees of freedom available in polycrystalline ceramic $ErMnO_3$ (**Figure 1**). We find a one-to-one correlation between the grain size and the type of domains, allowing us to induce mono-domain states, as well as vortex- or stripe-like domains on demand. [3, 4] Furthermore, we apply mechanical stress and variations in the cooling rate to adjust the density of vortex-cores and the periodicity of stripe-like domains. [5] We explain the effects by the interaction of vortex cores with elastic strain fields and grain boundaries. This interaction gives a new lever to tune the electromechanical and dielectric performance of polycrystalline ceramic ferroelectrics, providing novel opportunities for capacitor applications and domain wall based nanoelectronics.

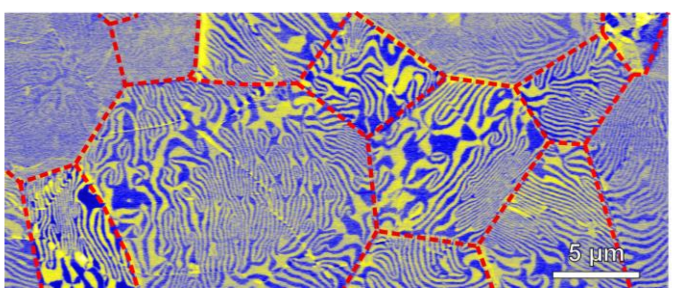

Figure 1. PFM image displaying the domain structure in polycrystalline ceramic $ErMnO_3$. Yellow and blue areas indicate ferroelectric domains separated by 180°. The dashed red lines highlight the grain boundaries.

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References:

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