Non-destructive mapping of long-range dislocation strain fields in an epitaxial complex metal oxide - DTU Orbit (14/10/2019)

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The misfit dislocations formed at heteroepitaxial interfaces create long-ranging strain fields in addition to the epitaxial strain. For systems with strong lattice coupling, such as ferroic oxides, this results in unpredictable and potentially debilitating functionality and device performance. In this work, we use dark-field x-ray microscopy to map the lattice distortions around misfit dislocations in an epitaxial film of bismuth ferrite (BiFeO3) - a well-known multiferroic. We demonstrate the ability to precisely quantify weak, long-ranging strain fields and their associated symmetry lowering without modifying the mechanical state of the film. We isolate the screw and edge components of the individual dislocations and show how they result in weak charge heterogeneities via flexoelectric coupling. We show that even systems with small lattice mismatches and additional mechanisms of stress relief (such as mechanical twinning) may still give rise to measurable charge and strain heterogeneities that extend over mesoscopic length scales. This sets more stringent physical limitations on device size, dislocation density and the achievable degree of lattice mismatch in epitaxial systems.

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