Implications of Ferroelectricity During the Growth of Ferroelectric Superlattices

Rui Liu[1], Alec Sun[1], Benjamin Bein[1], Hsiang-Chun Hsing[1], Anna Gura[1], Giulia Bertino[1], Jin-Wen Lai[1], and Matthew Dawber[1,*]
[1]Department of Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800
*Matthew Dawber: matthew.dawber@stonybrook.edu

In ferroelectric superlattices the constituent materials are often under considerable epitaxial strain, raising their ferroelectric transition temperatures to the point where they are comparable to or exceed the growth temperature. This has a number of important consequences for the growth of superlattices and their eventual properties which manifest themselves in a particularly interesting way in $PbTiO_3/BaTiO_3$ superlattices grown on $SrTiO_3$ substrates. As both components of the superlattice are ferroelectric and have elevated transition temperatures due to compressive strain from the substrate, a number of characteristics of the superlattices are extremely sensitive to layer thickness and growth temperature. For example, the as-grown polarization domain structure, as measured by piezoforce microscopy, is markedly different depending on whether the overall structure's transition temperature lies constantly below, constantly above, or oscillates around the growth temperature.

Perhaps more surprisingly, we have also found that the ferroelectric polarization of a growing structure has a strong effect on the rate at which it grows, which is critical information if high quality samples with well-defined layer thicknesses are to be achieved. We have studied this effect in detail by focusing on the properties of $BaTiO_3$ thin films grown on very thin layers of $PbTiO_3$ using a combination of x-ray diffraction, piezoforce microscopy and electrical characterization.

Further insight in to these effects is obtained by x-ray diffraction performed in-situ during the growth process, where the study of this effect represents one of the first experiments at the in-situ growth facility at the NSLS-II ISR beamline.

Acknowledgement: This work is supported by the National Science Foundation through grants DMR-1055413, DMR-1334867 and DMR-1506930.