Nanoscale layers of ferroelectric BaTiO$_3$: From growth to fabrication

Jayakanth Ravichandran
Mork Family Department of Chemical Engineering and Materials Science
Ming Hsieh Department of Electrical and Computer Engineering
Core Center of Excellence in Nano Imaging (CNI)
University of Southern California, Los Angeles CA 90089.

BaTiO$_3$ is a prototypical ferroelectric material with promise for next-generation memory and as ferroelectric layer for neuromorphic devices. Despite years of research, several outstanding challenges in the growth and fabrication of ultrathin nanoscale BaTiO$_3$ layers remain. Recent demonstration of ultralow switching in BaTiO$_3$ ferroelectric capacitors (coercive voltage < 100 mV) has piqued the interest of the community. Despite this impressive tuning of the coercive field, important parameters such as retention and endurance of these capacitors remain poor. In this talk, I will outline the advances achieved in my group to address these challenges. Specifically, we will show that by controlling both the interfacial and bulk perfection of SrRuO$_3$/BaTiO$_3$/SrRuO$_3$ heterostructure ferroelectric capacitors, we show endurance $>10^{11}$ cycles and retention $>10^4$ s. Next, we will show that careful control of the strain and mechanical constraint can enable free standing large area ferroelectric layers of BaTiO$_3$ and the related relaxor of alloy (Ba,Ca)(Ti,Zr)O$_3$. Our results show that perovskite ferroelectrics such as BaTiO$_3$ have a critical role to play in next generation nano-electronic devices.