IOWA STATE UNIVERSITY

Materials Science & Engineering Department

Hanzheng Guo

Final Oral Examination
PhD Student with Xiaoli Tan

Thursday, June 26 · 10AM · 1106 Pearson Hall

"*In situ* transmission electron microscopy study of the microstructural origins for the electric field-induced phenomena in ferroelectric perovskites"

Ferroelectrics are important materials due to their extensive technological applications, such as non-volatile memories, field-effect transistors, ferroelectric tunneling junctions, dielectric capacitors, piezoelectric transducers, sensors and actuators. As is well known, the outstanding dielectric, piezoelectric, and ferroelectric properties of these functional oxides originate from their ferroelectric domain arrangements and the corresponding evolution under external stimuli (*e.g.* electric field, stress, and temperature). Electric field has been known as the most efficient stimulus to manipulate the ferroelectric domains through polarization switching and alignment. Therefore, direct observation of the dynamic process of electric field-induced domain evolution and crystal structure transformation is of significant importance to understand the microstructural mechanisms for the functional properties of ferroelectrics.

In this study, electric field *in situ* transmission electron microscopy (TEM) technique was employed to monitor the real-time evolution of the domain morphology and crystal structure during various electrical processes: (1) the initial poling process, (2) the electric field reversal process, and (3) the electrical cycling process. Two types of perovskite-structured ceramics, normal ferroelectrics and relaxor ferroelectrics, were used for this investigation. In addition to providing the microscopic insight for some well-accepted phase transformation rules, discoveries of some new or even unexpected physical phenomena were also demonstrated.