Carnegie Mellon
Materials Science and Engineering Seminar Series
Materials Research at Carnegie Mellon

Patrick Fisher

Graduate Research Assistant
Department of Materials Science and Engineering
Carnegie Mellon University

"Thin film growth mechanisms, phase stabilities, and cation transport in the $SrO\text{-}TiO_2$ system grown with layer-by-layer molecular beam epitaxy**"**

Friday, April 13, 2007
11:00 A.M. Seminar in Baker Hall 136A
Refreshments precede seminar at 10:30 A.M. in 2325 Wean Hall

Research into the synthesis-structure-property relationships in perovskites and related structural families is intense and ongoing owing to the wide range of exciting physical properties that they display. Conventional thin-film synthesis methods based on co-deposition of cationic species are restricted to an uncontrolled surface equilibrium and result in an unnecessarily narrow viewpoint of the actual mechanisms and stabilities that are present on the atomic scale. In order to observe these mechanisms at play, in this work MBE growth with monolayer control is used to produce initial structures with controlled initial ordering of SrO and TiO_2 oxide monolayers. Kinetic processes in some cases then cause the films to reorder, depending on layer arrangement. Non-stoichiometry during growth can be observed through RHEED observation, and can also be observed by XRD in select cases. Despite the monolayer control, MBE was found to be unsuitable to produce films with spatially separated Sr and Ti cations; diffusion of the oxides was unavoidable, and the result was the consistent, reproducible nucleation and growth of highly crystalline, epitaxial, relaxed perovskite $SrTiO_3$. Different shuttering techniques are employed and the resulting growths are compared, determining that the "pulsed" shuttering method results in a highly comparable series of films to the fully shuttered series. Shuttered growth is then utilized to synthesize artificial phases, including Sr_3TiO_5, Sr_4TiO_6, and Sr_5TiO_7. The new phases are characterized by RHEED, XRD, and TEM and the structures and stability are discussed.

Patrick received his Bachelor degree in Engineering Physics from the University of Pittsburgh in 2003 and his Masters in Materials Science and Engineering in 2004 from Carnegie Mellon University. He is currently a Ph.D. candidate under the guidance of Prof. Skowronski and Prof. Salvador.