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"Nucleation and growth of kinetically frustrated metastable materials as thin films"

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Developing synthesis routes to form new materials has always fascinated material scientists. The challenge becomes even more interesting when the material under consideration is metastable and it is difficult, if not impossible, to synthesize it using standard bulk approaches. Thin film deposition offers several alternative approaches to synthesize metastable materials. The most common approach is called epitaxial stabilization, in which phase selection can be treated from solely a thermodynamic perspective; in other words, one assumes the growth of compounds occurs on the surface with appreciable diffusion, no desorption, and fast reaction. In this talk I will discuss cases where the above assumptions during epitaxial growth do not hold true and kinetics play an increasingly important role in phase selection during nucleation and growth. The affect of surface diffusion on phase selection will be discussed with respect to the growth of $RE_2Ti_2O_7$ (*RE* = rare earths) compounds. It will be shown that the growth of the (110)-layered perovskite polymorph of $RE_2Ti_2O_7$ compounds is kinetically frustrated and that the system can be captured in a previously-unknown, kinetically-preferred polymorph (we call the γ-polymorph). This is a unique observation as it shows that diffusion can direct phase selection kinetically during film growth. For complex oxide compounds, containing volatile components (e.g., Bi-based compounds), both desorption and reaction rates affect phase formation. Maintaining both global and local stoichiometry is a major challenge in the growth of such compounds. I will present a systematic study of the effects that different deposition parameters have on the film composition of $BiMnO_3$ and $Bi_2Ti_2O_7$. The effect of reaction rate between the constituent species on film composition and phase formation will also be discussed. Two novel growth approaches that overcome desorption and reaction rate issues and lead to stoichiometric epitaxial film growth of Bi-based compounds will also be presented.

Sarthak received his Bachelors degree in Materials Science and Engineering from the Indian Institute of Technology, Kanpur in 2005 and his Masters degree in Materials Science and Engineering from Carnegie Mellon University in 2007. He is currently a Ph.D. candidate under the guidance of Prof. Salvador.