Yale Institute for Nanoscience and Quantum Engineering

Friday- September 18, 2015

12:00 to 1:00 p.m.

BECTON SEMINAR ROOM

Arvin Kakekhani

Department of Applied Physics, Yale University

"Ferroelectrics and their potential to solve the most fundamental challenges of catalysis"

The effect of ferroelectric polarization on surface physics and chemistry has been studied for more than six decades. It is shown that ferroelectric polarization can affect the adsorption energies, adsorption modes, and reaction rates of a variety of polar and non-polar molecules. Surface catalysis based on transition metals and their alloys has been one of the most important research fields in theoretical and experimental catalysis and chemistry. Despite, enormous impacts on daily lives, e.g., helping to overcome the world's hunger problem in the early 20th century, by introducing the Haber-Bosch process to efficiently synthesize ammonia, transition metal-based catalysis now faces some fundamental limitations. As a result of these limitations, some of the most important chemical reactions still lack an efficient catalyst e.g., selective partial oxidation of methane to methanol, or NO direct decomposition. We suggest that ferroelectrics may make an important contribution in this regard. Ferroelectric surfaces have an added degree of freedom which is the direction of the polarization below the surface. Exploiting this tunable degree of freedom, results in a dynamic control over the surface chemistry, which can potentially free us from the fundamental limitations posed on catalytic efficiency by the Sabatier principle, and scaling relations. As a specific example, I will discuss using a class of ferroelectric-based catalysts to efficiently catalyze NO direct decomposition ($2NO \rightarrow N_2+O_2$).

Jie Shen

Department of Mechanical Engineering & Materials Science, Yale University

"Revealing surface states in topological crystalline insulator SnTe material class"

Topological insulators are a class of quantum materials which have unique surface states that follow Dirac energy dispersion and are topologically protected by time-reversal symmetry. The recently discovered topological crystalline insulators (TCIs), a SnTe material class, expand the ever-growing family of topological insulators. Instead of time-reversal symmetry, crystalline symmetry protects the topological phase in TCIs. By doping SnTe, we study topological properties of SnTe. First, we dope SnTe with Indium, a candidate of a topological superconductor. In-doped SnTe can provide a platform to create Majorana fermions and realize topological quantum computing. Second, Selenium is doped into SnTe to effectively reduce the bulk carrier density, a critical step toward the use of the surface states.

Host: Professor Eric Altman