The Structure and Chemistry of Solid Surfaces

The structure of solid surfaces and the chemical reactions that take place on surfaces are of fundamental importance to a wide variety of technological problems. For example, catalytic converters in automobiles have dramatically reduced the atmospheric pollutants in automobile exhaust. The chief component of automotive catalysts are precious metals such as platinum or rhodium and the key chemical reactions involved in the removal of pollutants such as carbon monoxide, unburned hydrocarbons, and nitrogen oxides, take place on the surfaces of the metal particles contained in the catalysts. This is an example of heterogeneous catalysis, a method that is widely used to promote desired chemical reactions. Other technological fields that require a detailed understanding of surface properties include nanoscience and nanotechnology, semiconductor manufacturing and processing, and various strategies for developing alternative energy sources. Prof. Trenary's laboratory contains an array of advanced surface science instrumentation for investigating fundamental aspects of the structure of solid surfaces as well as the chemical reactions that take place on the surfaces of metals and metal oxides.[1]

The REU student will work will graduate students and other members of Professor Trenary's research group on a project exploring surface chemical reactions related to problems in heterogeneous catalysis. This project combines information from atomically resolved images of surfaces obtained with scanning tunneling microscopy (STM) with spectroscopic information obtained with the technique of reflection absorption infrared spectroscopy (RAIRS). More specifically, surface chemical reactions involving the hydrogenation and dehydrogenation reactions of simple molecules on transition metal surfaces and of transition metal clusters deposited onto oxide surfaces will be studied. The use of organometallic precursors is an attractive method for depositing metal nanoparticles onto oxide surfaces for the purpose of conducting fundamentals studies on model catalysts.

The REU student will be expected to understand the issues and challenges related to this project and to gain a general understanding of surface science methods and concepts. The student will work closely with a PhD candidate to master ultrahigh vacuum methods and techniques for surface analysis can characterization.

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1. Y. Lei, A. Uhl, C. Becker, K. Wandelt, B. C. Gates, R. Meyer, and M. Trenary, "Adsorption and Reaction of $Rh(CO)_2acac$ on $Al_2O_3/Ni_3Al(111)$", *Phys. Chem. Chem. Phys.*, 12, 1264-1270 (2010)