Physics Department Senior Design Project Proposal

Project Mentor: Tom Furtak, x3843, tfurtak@mines.edu

Project Title: Surface Characterization using Polarization Modulation Infrared Spectroscopy

Project Type: [x] Team; Number of students: 2 [ ] Honors

Objective

The outer molecular layers of a material frequently control its chemical stability and charge transfer nature. Understanding these layers is difficult, since there is so little material. Special techniques are necessary. We have recently acquired a state-of-the-art infrared spectrometer that includes a unique polarization-modulation accessory. The objective of this project will be to use this instrument for the measurement and analysis of several important molecular systems, particularly nanoscale monolayers involving light-activated molecular motors.

Prior Background

Our group has considerable experience with molecular layers on surfaces in applications ranging from friction control to polymer photovoltaics. The new instrument comes with extensive documentation and a suite of impressive software tools.

Student Expectations

Students learn to operate polarization-modulation infrared spectrometer. They will design experiments involving the preparation and processing suitable configurations involving organic monolayers on glass and metal oxides. Finally, they will measure and interpret the vibrational spectra of samples before and after exposure to light (which will alter their characteristics). The final objective will be to determine the chemical identity of and dose sensitivity of the photodecomposition product.

Supervision Plan

Day to day supervision will be coordinated with a senior grad student. Students will meet as a team with Prof. Furtak once a week.

Resources

The new spectrometer has just been installed. Sample preparation materials are either in place or will be ordered under the sponsorship of a grant from the National Science Foundation.

Technical References

D. Roy and J. Fendler, “Reflection and absorption techniques for optical characterization of chemically assembled nanomaterials”, *Advanced Materials* **16**, 479 (2004).

A. G. Lambert, P. B. Davies, and D. J. Neivandt, "Variable index of refraction ultrathin films formed from self-assembled zirconium phosphonate multilayers: Characterization by surface plasmon resonance measurements and polarization-modulation FTIR spectroscopy," *Analytical Chemistry* **67**, 3767 (1995).