

Physics Department Senior Design Project Proposal

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

Project Title: Sum-Frequency Spectroscopy of Adsorbed Monolayers

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

Objective

Self-assembled monolayers of organic molecules are being used to change the chemical and electronic characteristics of semiconductors and oxides in molecular electronic applications. Understanding these monolayers is a key objective in nanoscale engineering. This project involves using surface nonlinear optical methods to obtain the vibrational spectrum of a single molecular layer. The system that we'll study is a monolayer of an alkanethiol on gallium arsenide.

Prior Background

Our group has constructed a sum-frequency vibrational spectrometer, based on a pulsed-dye laser system with a high-pressure stimulated Raman infrared laser. The performance of the system was recently optimized through component upgrades and re-alignment of the entire laser instrumentation configuration.

Student Expectations

Students learn to operate the multi-laser hardware, including the necessary LabView interface routines that manage the dye-laser tuning and the gated detector signal acquisition. Treated GaAs materials will be provided through a collaboration with Buena Vista University. Experiments must be designed to properly identify the surface orientational distribution of the molecules attached to the samples. Deliverable will be an SFG spectrum of a self-assembled layer of alkanethiol adsorbed to GaAs by the end of the academic year. A bonus goal would be analysis of the data to determine the orientation distribution function of the molecules in the layer.

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 surface nonlinear optical system is in place. Expendables will be purchased with funding from the National Science Foundation.

Technical References

B. C. Chow, T. T. Ehler, and T. E. Furtak, "High-resolution sum-frequency generation from alkylsiloxane monolayers", *Applied Physics* **B 74**, 395 (2002).

A. G. Lambert, P. B. Davies, and D. J. Neivandt, "Implementing the theory of sum frequency generation vibrational spectroscopy: A tutorial review," *Applied Spectroscopy Reviews* **40**, 103 (2005).