DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE WOMEN

APPLICATION DEADLINE: MARCH 1, 2002

The Department of Materials Science and Engineering is pleased to offer the following research projects for the summer of 2002. Interested students are urged to contact the faculty member(s) directing the project(s) that most interest them. By contacting the faculty member, you can discover more about the project, learn what your responsibilities will be, and if possible, develop a timetable for the twelve-week research period.

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1. Optical Emission in Plasmas

Plasmas are low-pressure gases that contain ions, free radicals, and other electronically excited species. We use plasmas to etch or remove material from the surfaces of materials or to deposit ultra-thin films onto the surfaces of materials. Because plasmas contain electronically excited species, they emit light in the visible and UV regions of the spectrum. One very important area that we are interested in exploring involves the use of optical emission spectroscopy (OES) to identify the excited species present in plasmas as a function of experimental variables such as pressure and applied power. Successful identification of these species as a function of experimental variables will enable the plasma etching and deposition processes to be controlled. We are especially interested in plasmas that contain acetylene. Thin films deposited from these plasmas are being investigated as primers for adhering rubber to metals in applications such as sonar transducers on nuclear submarines. The National Science Foundation (NSF) is sponsoring this research project.

2. Plasma Polymerized Primers for Rubber-to-Metal Bonding

Adhesion of rubber to metals such as steel and aluminum is important in many areas of technology, including fabrication of sonar transducers for nuclear submarines and steel-belted radial tires for motor vehicles. However, most rubbers do not adhere well to metals. Therefore, the surface composition of a metal must be modified in some way to make it possible for a rubber compound to adhere to the metal. Although many techniques for modifying the surface composition of metals to enable adhesion of rubber are used industrially, most involve wet chemical processes that are not compatible with the environment. We have already shown that thin films deposited onto metal substrates in plasmas that contain acetylene are excellent primers for adhering rubber to metals and that the plasma deposition process is compatible with the environment. The goal of this research will be to determine the mechanisms by which plasma polymerized acetylene films adhere to steel substrates. We will use sophisticated analytical techniques such as X-ray photoelectron spectroscopy (XPS) and Fourier-transform infrared spectroscopy (FTIR) to determine the molecular structure of plasma polymerized acetylene films as a function of film thickness. As the thickness of the films is decreased from a few hundred angstroms to just a few angstroms, features in the XPS and FTIR spectra that are characteristic of the bulk of the films should decrease in intensity and features that are characteristic of the film/substrate interface should increase, making it possible to identify structures in the films that are responsible for adhesion to the substrate. Once we understand the mechanisms responsible for adhesion at the interface between plasma polymerized acetylene and steel, it should be possible to design plasma polymerized films that are even more effective as primers for rubber-to-metal bonding. The National Science Foundation (NSF), Caterpillar, Inc., and the Goodyear Tire & Rubber Co. are sponsoring this research project.

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<u>Synthesis and Properties of Diamond and Cubic Boron Nitride Thin Films for High Temperature Electronic Devices</u>

High temperature electronics has emerged as a very important area because the dominant silicon electronics provides low reliability or fails to function altogether at elevated temperatures. Applications which depend on high temperature electronics are not only limited to military systems, but include commercial utilization in air/space travel, automobiles, smog control, geothermal energy, well-logging, and nuclear reactor monitoring and control.

The primary objectives of this project are to synthesize and characterize nanocrystalline thin films of high resistivity (undoped), and p- and n -doped polycrystalline diamond (PCD) and cubic-boron nitride (c-BN) suitable for the fabrication of high temperature electronic devices, and application/demonstration of these films for the fabrication of high temperature microelectronic devices.

The thin films of undoped diamond have been prepared by ECR (Electron Cyclotron Resonance) plasma enhanced chemical vapor deposition (ECR-PECVD) on (100) Si substrates. The influence of different process parameters (e.g., plasma gas composition, substrate temperature, pressure, and plasma density) on the composition, crystal quality, and properties of the PCD and films are being studied. In addition, I-V and resistively measurements are determining electrical properties of the films.

Students will be assigned to work on this project. In particular, students will gain experience in processing Diamond and c-BN thin films and measurement of some of their properties. Characterization of the films by advanced techniques such as Scanning Electron Microscopy, Raman Spectroscopy, and other materials characterization techniques will also be done. Students will be working under the guidance of the Professor Singh, the Principal Investigator for this externally funded research project.