

## REU 2006 STUDENT ABSTRACTS

### **Infrared Spectroscopy: Temperature Effects of Molecular Conformation of Antifreeze Glycoprotein in Aqueous Solution and Ice**

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#### **Abstract**

This project applied Infrared spectroscopy to investigate the conformation changes of antifreeze glycoproteins – 8 (AFGP-8) molecules with the temperature in the area of molecule/water/ice interactions. An IR spectrum of AFGP-8 thin film at room temperature was successfully acquired through the range  $500\text{ cm}^{-1}$  to  $4000\text{ cm}^{-1}$  for the first time. The IR result was compared with the result of Raman spectroscopy collected in temperature range of approximately  $25^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$ , which shows changes of intensity at peak  $798\text{ cm}^{-1}$  and peak  $828\text{ cm}^{-1}$ . These two peaks were assigned to the bend vibration of CCO bond in the sugar side train of AFGP-8 molecule using Analyzelt Raman of KnowItAll informatics system software from Bio-Rad Laboratories, Inc. However, the IR spectra of AFGP-8 film does not show these two peaks at room temperature, but the peak for Amide-II shows well, which doesn't appear on Raman spectra. The IR spectra of AFGP-8 film on  $\text{BaF}_2$  substrate for temperatures below  $0^{\circ}\text{C}$  exclude these two peaks of interest because the  $\text{BaF}_2$  substrate blocked the signal. This research has the significant support for the understanding of the mechanism of antifreeze glycoprotein (AFGP-8) molecules adsorption to the crystal structure of ice.

### **Making and Testing Erbium Doped Glass for Its Uses in the Future**

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#### **Abstract**

The purpose of the research was to successfully create and test glass doped with various concentrations of erbium to identify or modify any real world applications that may exist in the present or future. The glass was tested for optical properties. This type of research can possibly be beneficial to the future of erbium and its applications in glass.

Glass was doped with erbium to change the properties of the glass. A molar concentration of 0.6 and 1.2 was added to the glass. It was tested using a spectrophotometer to see the transmittance properties. The glass with the erbium was more transparent than the undoped glass. The erbium gave the glass a light pink tint. Without the erbium, the lead in the glass took over the appearance. The undoped glass had a dark yellow tint. The undoped was also more brittle than the erbium doped glass. Due to time restraints, the 1.2 concentration erbium doped glass did not get tested for optical properties.

## **From Raman to Infrared Spectroscopy of Antifreeze Glycoprotein**

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### **Abstract**

The first objective in this experiment was to use Raman Spectroscopy in order to obtain spectra for the Antifreeze Glycoprotein (AFGP) at different temperatures, which ranged from 26<sup>0</sup>C to -10<sup>0</sup>C. Unfortunately the Raman system was down, which caused the objective to be changed to Infrared (IR) Spectroscopy of the AFGP. Raman peaks of AFGP were analyzed and interpreted using computer software (Know It All Informatics System) then later were compared with those of IR. IR was also used to collect peaks of AFGP at different temperatures using the substrate BaF<sub>2</sub> with AFGP on a cooling stage which changed the intensity of AFGP peaks.

## **Oxidation of SiC by Carbon Dioxide**

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Others in Laboratory: Stephanie Turner

### **Abstract**

Well aligned, low defect, metal-free carbon nanotubes are known to grow on SiC wafers under high vacuum between 1400-1800<sup>o</sup> C<sup>1,2,3</sup>. Kusunoki *et al*<sup>1,2</sup> and Lu *et al*<sup>3</sup> report on oxygen's interaction in the formation of carbon nanotubes. Pursuit of this role will perhaps lead to controlled growth processes. Samples were annealed using a continuous flow of carbon dioxide for the growth process. X-ray Photoelectron Spectroscopy spectrums are presented for the 4H-SiC wafer, c-face samples annealed in

CO<sub>2</sub>. The data is presented to further develop the important interaction of oxygen with carbon and silicon which results in carbon nanotubes.

**Keywords:** Carbon nanotubes, CNT, XPS, X-ray Photoelectron Spectroscopy, Spectrum Analysis, Oxidation, SiC

## **The Importance of Pressure in Carbon Nanotube Growth**

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### **Abstract**

Using the Atomic Force Microscope (AFM) two samples supplied by the Air force grown under different conditions were analyzed. The first was a sample of C-face 6H-SiC grown using an applied EPI 930 MBE system at 1500°C with a base pressure of 10<sup>-8</sup> Torr.[1] The second sample was also C-face 6H-SiC grown using an applied EPI 930 MBE system at 1500°C, but with a base pressure of 10<sup>-7</sup> Torr instead of 10<sup>-8</sup> [1]. As a result of the different base pressures it was observed that the sample grown at 10<sup>-7</sup> torr had a larger quantity of nanocaps on the surface.

**Key Words:** Atomic Force Microscope and Carbon Nanotubes (CNT)

## **Properties of Cerium-Activated Glasses for Scintillator application**

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### **Abstract**

This research reports the study of the properties of cerium-activated glasses for scintillator application. Three base glasses consisting of 60SiO<sub>2</sub> · 6Al<sub>2</sub>O<sub>3</sub> · 34Li<sub>2</sub>O were prepared for analysis. Two glasses were doped with cerium as the scintillating agent while the remaining undoped glass was used as the control. The two dopant concentrations investigated were 0.6 mole percent of CeF<sub>3</sub> and 1.2 mole percent of CeF<sub>3</sub>. Each sample was prepared using a high temperature furnace for melting and a separate furnace for annealing. Absorption and photoluminescence spectroscopy was used to determine the optical properties of each glass sample and the glass structure was studied using Raman spectroscopy. The data collected indicated that although the glass sample containing 1.2 mole percent of CeF<sub>3</sub> had a higher Ce ion concentration than the glass sample containing 0.6 mole percent of CeF<sub>3</sub>, the glass sample containing 0.6 mole percent of CeF<sub>3</sub> emitted significantly more luminescence light.

## **Opening of Carbon Nanotube caps and removal of Amorphous carbon**

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### **Abstract**

Carbon nanotubes grown in a furnace at 1700°C at 10<sup>-5</sup> Torr without a metal catalyst have fewer defects than carbon nanotubes grown other standard methods. However during the growth process a layer of amorphous carbon also forms on top of the carbon nanotubes. Carbon nanotubes themselves are either highly conductive or semi conductors, the amorphous carbon limits the conductivity. Also once the carbon nanocaps are removed it is thought that the tubes can be filled with biological agents. Many methods for the removal of this layer of amorphous carbon and the carbon nano caps have been developed however these methods are detrimental to the carbon nanotubes themselves resulting in greater defects and loss of the tubes. Annealing the sample under CO<sub>2</sub> is thought to be mild enough to remove only this top layer of carbon and the caps. Therefore different annealing temperatures were evaluated using SEM, and TEM.

### **0.6 molar concentration of ErF<sub>3</sub> vs. a 1.2 molar concentration of ErF<sub>3</sub>**

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### **Abstract**

There was a set of samples made on a 0.6 mol. concentration of ErF<sub>3</sub> and a 1.2 mol. concentration ErF<sub>3</sub>. A third sample was made for the 1.2 mol. concentration of ErF<sub>3</sub> this was done because the annealing process was left out while preparing the glass. The importance of annealing is to reduce the cracks on the sample's surface. While testing for the transmittance properties in the 1.2 sample of ErF<sub>3</sub> the readings Carry 500 tested for transmittance properties in a 0.6 mol. concentration of ErF<sub>3</sub> as well as that of a 1.2 mol. concentration. In the first run of the 0.6 mol. concentration of the transmittance was approximately 64% while the transmittance of the 1.2 mol. concentration of ErF<sub>3</sub> was approximately 86%.

### **An X-ray Photoelectron Spectroscopy study of Carbon Nanotubes on Silicon Carbide crystals**

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### **Abstract**

The surface structure and elemental composition on silicon carbide crystals in relation to the presence of CNTs was determined. Using X-ray Photoelectron Spectroscopy (XPS), the silicon carbide surface structures were studied and analyzed with respect to different angles by incorporating angle resolved XPS. After the XPS spectra data was collected, the peaks were analyzed in relation to their corresponding binding energies to determine elemental and compound composition at the surface of the silicon carbide crystals. It was determined that *less* silicon was recorded on XPS spectra near the surface and great amounts of graphitic carbon *were* recorded near the surface correlating to the presence of CNTs.

### **Scintillation properties of cerium-doped glass**

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### **Abstract**

The scintillation properties of a cerium doped  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-LiCO}_3$  glass are investigated. Two different concentrations of  $\text{CeF}_3$ , 0.6 g/mol and 1.2 g/mol are investigated. A sample of undoped host glass is also checked as a control. The luminescence and transparency of the glass samples are examined to determine whether these specific concentrations of glass are suitable for scintillation uses. Both samples showed photoluminescence peaks at approximately 375 nm and 400 nm. All three samples of glass showed a very similar transmission percentage curve, with the undoped sample mol/g sample being significantly more transparent at the scintillation wavelengths. The 0.6 g/mol sample had significantly higher scintillation counts.

### **Growth of Scintillator Crystals**

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### **Abstract**

The purpose of this lab experiment was to produce single-crystals with scintillating properties, and was later tested for good detectors of radiation from gamma, x-ray, and beta particles. These single-crystals would consist of specific compounds that contain scintillating elements, BaI<sub>2</sub> and KPb<sub>2</sub>Cl<sub>5</sub>. A Raman Spectrometer and oscilloscope was used to visualize and record the readings from the characterization process. The graphs from the readings of both single-crystals were later compared and the conclusion stated below.

## **Surface images and electrical properties using Silicon carbide annealed at 1400°C with Oxygen and Carbon dioxide Gases**

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### **Abstract**

The purpose of this research is to investigate the mechanism of carbon nanotubes (CNTs) growth using Atomic Force Microscopy (AFM). Since using AFM, the growth of carbon nanotubes (CNTs) can not be determined; other equipments such as X-ray photoelectron spectroscopy (XPS) and High Resolution Transmission Microscope (HRTM) will used to analyze growth. With AFM only morphological features on surface sample can be analyzed and electrical characteristics to see if the samples are conductive. The samples used were Silicon Carbide (SiC) grown in furnace at a temperature of 1400°C with a pressure of 10<sup>-5</sup> torr in high vacuum using two different gases such as carbon dioxide (CO<sub>2</sub>), and oxygen (O<sub>2</sub>). The results have shown that there was surface growth on both samples, but the 1400°C sample with CO<sub>2</sub> was analyzed for electrical conductivity due to equipment failure, while the 1400°C sample with O<sub>2</sub> gas had electrical properties.

**Keywords:** Silicon carbide (SiC), carbon nanotubes (CNT), conductive atomic force microscopy (CAF), and atomic force microscopy (AFM)