

Fisk University REU 2005 Abstracts

“The Growth of an Optical Crystal Using the Bridgman Method”

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Advisor: Dr. U Roy, Dr. A Burger, Dr. L Bai, and Mr. R Hawrami

Abstract

An optical crystal can be grown different ways such as; solid to solid (S-S), liquid to solid (L-S), and vapor to solid (V-S). The method we choose to use was the Bridgman Method (L-S). We first had to purify the material using a vacuuming process and clean the tube of any impurities. Then the temperature was measured for different vertical regions of the furnace. After which when all the equipment was setup we grew the crystal in a downward vertical direction. Starting from a molten state and cooling to a solid state. After the crystal was grown we then cut and polished to rid of any major surface defects. Then we characterized the crystal optically using an optical absorption spectrometer and thermally using differential scanning calorimetry (DSC).

Scintillating Glasses for Detection of Ionizing Radiation

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Abstract

This research was proposed to investigate the effects of structure and composition on scintillation performance for Ce^{3+} and Tb^{3+} doped glasses. Structures of the fabricated glasses were intended to be investigated using infrared and Raman spectroscopy. Optical properties were to be determined from UV-visible absorption and photoluminescence spectroscopy. The results of these measurements were intended to be correlated with scintillation efficiency.

Study on the Effects that Different Metals as Contacts has on an IMARAD $Cd_{1-x}Zn_xTe$ Radiation Detector

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Faculty Advisor:
M. Groza, V. Buliga and Prof. A. Burger

Abstract

Cd_{1-x}Zn_xTe (CZT) is an attractive semiconductor material for room temperature x-ray and gamma-ray detector applications [1]. An IMARAD 20x20x4.5 mm³ CZT crystal was the sample utilized in this study. The detector was polished up to .05 μm in a wet mechanical process using gradual abrasives. Before depositing metal contacts the crystal was inspected using infrared topography to see the defects within the crystal and at the surface. Titanium and gold contacts were deposited by sputtering using photolithography.

Guarded pixilation configuration was chosen to compare the two metals Au and Ti. Each time both sides were of same material (Au-Au, Ti-Ti). Characterization was done on three representative pixels-corner, side and center of the crystal and consisted of bulk and surface Current-Voltage, as well as Detection Response- Cs 137 Spectra. Gold contacts proved to perform better.

Antimicrobial Properties of Essential Oils against *Candida Albicans*

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Advisor Professor Guna

Abstract

Antimicrobial properties are agents slows the growth of a microorganism or destroys the microorganism all together. *Candida albicans* are usually found in the mouth, vagina, and intestinal tract. *Candida albicans* causes the infectious disease candidiasis, and is also known as thrush. Essential oils have been found to have an antimicrobial property that suppress or eliminates the growth of certain microorganisms. Plants contain and produce antimicrobial compounds like terpenes and flavanoids, which are secondary metabolites, which can inhibit cell activity of certain microorganisms that cause harmful infections. We took twelve essential oils all of them known for having antibacterial, anticytosolic, or antifungal properties to identify which would be the most effective against *Candida albicans*. Juniperus communis was the most effective essential oil (EO). It was one of only two oils which antimicrobial properties could withstand higher temperatures than the rest of the essential oils and between those two Juniperus communis created the greatest inhibition zone.

Analysis of Carbon Nanotube film on SiC using X-ray photoelectron spectroscopy (XPS)

Ismaila Badjie
Research partner: Jessica Sammons
Faculty Advisors; Dr W. Lu, Dr. S. Sambandam, Ms T. Crenshaw

Abstract

Carbon nanotubes (CNTs) are formed on SiC surface at high temperatures and low oxygen pressure. The CNTs/SiC samples in our research were analyzed using XPS techniques to study the chemical and elemental compositions of these samples. It is observed that the carbon nanotube/graphite features appear on surfaces as well as oxygen species on the surface and in the CNTs. All three our samples were prepared at 1500, 1700 and 1800°C respectively and resulted in the formation of graphitic features, which consists of C-C in CNTs/graphite, C-O and C=O on the surface. Angle resolved XPS techniques have revealed the atomic concentration changes in depth at various reaction temperatures.

Carbon Features on SiC Using Atomic Force Microscopy

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Abstract

In the present research, molecular beam epitaxy was employed to produce 1 sample of 4H-SiC and 2 samples of 6H-SiC. The 4H- SiC and 6H-SiC were annealed at 1400°C at a base pressure of 10⁻⁵ torr. Atomic Force Microscopy measured the topography and electrical characteristics of the various SiC sample surfaces with sub nanometer scale resolution. Five regions on each sample were chosen for AFM analysis as well as production of voltage curves for the respective areas. Regions on the AFM images indicated two distinct types of carbon features. Circular carbon features on the areas on the 4H and 6H were observed and the voltage curves of the respected regions proved the areas to exhibit rectifying contact as well as practical “non”-linear contact. In certain regions on the 6H-SiC, carbon features were observed to grow in a triangular, flat manner. Voltage curves of the areas proved the sample to exhibit rectifying contact.

Solving the Schrödinger and Modified Klein-Gordon Equation for Different Potentials

Buford Leroy Richardson, II
Research Partner: Mr. Brandon Averette, Esq.
Research Advisor: Dr. W. E. Collins

Abstract

The purpose of the research was to find solutions for the Schrödinger and modified Klein-Gordon equation by using Mathematica and the perturbation method of approximation for different potentials. No results were able to be found for the $-k/r+k^2/(2r^2)-k^3/(6r^3)$ and $e(-k/r)$ potentials using Mathematica, but solutions were found for the $-k/r$ and $-k/r+k^2/(2r^2)$ potentials. With the perturbation approximation method, no solutions were able to be found with the $-k/r+k^2/(2r^2)-k^3/(6r^3)$, but solutions were found with the $-k/r+k^2/(2r^2)$ and $e(-k/r)$ potentials. When comparing the known solutions for the Schrödinger equations with different potentials, the energy differences were very small. Also, when comparing the solutions of the modified Klein-Gordon and Schrödinger equations, the energy differences were also very small.

A study on the growth of carbon nanotubes from SiC

Jessica Sammons

Research Partner: Ismail Badjie

Research Advisors: Dr. W. Lu, Dr. S. Sambandam, Ms. Tiffany Crenshaw

METHODS OF SOLVING QUANTUM MECHANICAL DIFFERENTIAL EQUATIONS

Brandon Averette

Research Advisor: Dr. Eugene Collins

Research Partner: Buford Richardson II

Abstract

Quantum mechanics has provided some of the most accurate predictions of physics and this has often been done by its mere approximations. In this work attempts will be made to solve for a new proposed potential as well as some expansions of that, which include the currently accepted potential, and should that not be readily possible attempts will be made to solve at least more accurate approximations. This will be attempted using Mathematica, the method of Frobenius, and as a last resort approximation techniques. When this was done two analytical solutions and one approximate solutions were found while the three term expansion potential yielded to no answer.

SCREENING FOR ANTIMICROBIAL COMPOUNDS FROM HIGHER PLANTS

Uwem Umontuen and Quincy Winston

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Abstract

Plants possess antimicrobials in their leaves that can be utilized to resist pathogens that can afflict the human body. *Candida albicans* is an example of a opportunistic pathogen that can affect humans. From our study of *C. albicans*, only three plants were effective against it. The plants include garlic (*Allium sativum*), onion (*Allium cepa*), and basil (*Ocimum basilicum*).

Teaching Neutrino Oscillations on the Undergraduate Level

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There is a need for an introduction to neutrino oscillations accessible to sophomore level students. We plan to write a paper to introduce neutrino oscillations understandable by a student with a semester of modern physics. Oscillations for these students should be introduced in terms of waves, not matrices and Dirac notation as is usual for higher level students. Detailed explanation of how to use data from the KamLAND detector to find values for and is included.

“Metal Semiconductor Contacting Using Photolithography Techniques”

Fisk University, Nashville, TN
Summer Research Program/Research Experiences for Undergraduates (REU)
June 1- July 31, 2005

Nathan Campbell
Research Advisors: Michael Groza, Vlad Buliga, and Prof. Arnold Burger
Research Partner: Eric Woodard

Abstract

$\text{Cd}_{1-x}\text{Zn}_x\text{Te}$ (Cadmium Zinc Telluride or CZT) can be used as a nuclear radiation detector for medical, space, and national security applications. A $20 \times 20 \times 5$ mm³ crystal was studied using a 3×3 pixel configuration with gold (Au) contacts. The use of photolithography in metal contact deposition allows for complex configurations which lead to better detection results. One of the biggest assets of using the photolithography technique is the ability to apply a steering grid around the pixilated format. A steering grid surrounding the pixels provides an additional parameter for improving the charge collection. Current-voltage (I/V) and radiation detection were two of the main tests run on the crystal to measure different characteristics. Results show that having a steering grid greatly reduces the pixel to cathode charge collection. Radiation detection results prove the usefulness of the steering grid.

Raman Spectroscopy of Antifreeze Glycoprotein in D2O Adsorbed on Mica

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Abstract

Adsorption of Antifreeze Glycoprotein (AFGP) on mica substrate was studied using Raman Spectroscopy. Five new peaks—1002 cm⁻¹, 1155 cm⁻¹, 1200 cm⁻¹, 1356 cm⁻¹, and 1510 cm⁻¹—were discovered from the adsorption of AFGPs (6,7,8) in H₂O on the mica surface. To assist in identifying the new peaks, the adsorption of AFGP in dideuterium oxide (D₂O) on mica was also studied using Raman Spectroscopy. Only two new peaks remained—1002 cm⁻¹ and 1356 cm⁻¹. After a longer drying period, one new peak remained in the AFGP in D₂O spectrum, 1002 cm⁻¹.

Morphological Analysis of Bacteria Using Atomic Force Microscopy

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Abstract

Threats of biological warfare have increased interest in spore producing bacteria such as *Bacillus Stearothermophilus* and *Bacillus Anthracis*. Left untreated, the inhalation of *Bacillus anthracis* spores by humans often leads to internal bleeding, server damage to the tissue of major organs, and respiratory failure. In this investigation, the effects of temperature stress on the morphology of *Rhodospirillum rubrum*, *Micrococcus roseus* and *Bacillus stearothermophilus* were studied using Atomic Force Microscopy (AFM). In this report special attention is given to the sporulation of *Bacillus Stearothermophilus*, under atmospheric variations. Additionally, *Micrococcus roseus* and *Rhodospirillum rubrum* were observed via AFM after atmospheric and nutritional variations, respectively. Results of this study indicate that the induction of thermal stressors largely inhibited growth, altered structural morphology, and influenced the germination of spores.

Morphological Analysis of *B. Stearothermophilus*, *R. rubrum* and *M. roseus* using Atomic Force Microscopy: CO₂ Stress Observation

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Ms. Tiffany Crenshaw, Ufoma Akoroda and Dr. Weije Lu

Abstract

The application of physical stress to microorganisms is a widely used method to observe change in cell morphology. Furthermore, in certain species stress prompts the process of sporulation. To survive, microorganisms have evolved physiological mechanisms to tolerate extreme condition. The progression and method of their natural defenses are indeed significant threats as biological terrorism escalates. In this investigation, *Bacillus stearothermophilus*, *Rhodospirillum rubrum* and *Micrococcus roseus* were stressed thermally. In addition, *B. Stearothermophilus* was stressed atmospherically, and via pH; *R. rubrum* was stressed nutritionally; and *M. roseus* was stressed atmospherically. In the present study, we observed changes in the bacterial surface morphology attributed in response to induced environmental stressors.

Evaluation of SpectRIM Slide for the Signal Enhanced Raman Spectroscopy of Lower Concentration D-Glucose Solution

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Abstract

Evaluate Raman signal enhancement of D-glucose on SpectRIM slide from Tienta Sciences, Inc. The enhancement factor is about three times comparing with that on quartz slide. Lower concentration glucose solution has higher enhancement factor. SpectRIM slide is better for lower concentration glucose Raman measurement.

The Effect of CdSe Quantum Dots on the Optical Properties of Poly 2-methoxy-5-(2-ethylhexyloxy)-1,4-phenylenevinylene (MEH-PPV)

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Abstract

We studied the optical properties of MEH-PPV, a polymer that is used for solar cells. We tested the polymer at different concentrations. CdSe quantum dots (QDs) were added with ratio of 1:1 μL . The idea was to optimize the optical absorption efficiency in a specific range of photon energy of the polymer. An Ultra Violet-Visual spectrophotometer was employed to study the optical absorption in the range of 350 nm to 800 nm, which is of the major portion of sunlight. The samples were made by spin coating the polymer and the blend onto glass substrates. However, in order to make the polymer and the quantum dots compatible we had to give both the same solvent. Chloroform was chosen because the quantum dots were already in chloroform to keep them steady. The polymer is originally in powder form. We mixed .01 grams of the polymer with different amounts of chloroform. From our results we found that at different concentrations the polymer still absorbed very well at 500 nm. Our data also lets us know that the presence of the quantum dots allowed the blend to increase optical absorption efficiency from 600 nm to 800 nm. It is believed that this corresponds well to the optical band gap of the particular semi-conductor CdSe QDs. We have also found that the blend is recyclable and when recycled it loses no more than thirty to forty percent efficiency. The reason the blend had to be recycled was that the individual solutes were stored in different ways. When the blend was stored in the refrigerator as the pure liquid polymer is, the blend dried out. When the blend was stored at room temperature as the CdSe quantum dots were, the blend, again dried out. Fifty μL were added to the blend in order to recycle it.

The construction and testing of a vacuum system for the use of Pulsed Electron Deposition

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Abstract

The pulsed electron deposition (PED) system has been constructed. Since a vacuum system is required for PED, the vacuum system has been assembled and tested. The base

vacuum pressure reached 10⁻⁷ Torr range with the combination of a mechanical pump and a turbo-molecular pump. The operating pressure of oxygen for PED is required in the range of 8-14 mTorr. In order to obtain such a stable pressure, a precision leak valve was used for a constant flow of oxygen during the pumping. Specific details on the parts of the system re discussed.

Phytoremediation of *Glycine Max* using silver, molybdenum, and copper variations in Hydroponic Solution

Abstract

This paper shows the relationship between ionic competition, phytoremediation, and nutrient uptake. **Phytoremediation**, the use of plants to purify the environment via mineral extraction, is the fundamental phenomena under observation. *Glycine max* (Soybean), was selected for this research because of its cash-crop property along with the ability to grow in low preservation conditions. The later property is indicative of essential mineral withdrawal from the soil in an effortless method. Using **Silver, Molybdenum, and Copper** in elemental form, **phytoremediation** was conducted; furthermore, roots, stems and leaves were analyzed by using the scanning electron microscope. The investigation revealed an uptake of specified minerals by the roots in trace amounts, however, none were observed in the stems and leaves. Hoagland's media was used with the addition of two, four, and six times concentrated **variables** in elemental form. Observation of the roots identifies **Silver** uptake in statistically significant amounts while, the uptake of **Molybdenum** and **Copper** was higher when lower concentrations were used.

Inorganic Nanocoating

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Abstract

The control of nano-surface chemistry is an important in many respects, specifically to the area nanosphere lithography were the wettability, roughness, thickness and uniformity of the film are excessively important. Formation of silica sol to be used as an inorganic nanocoating material was the main focus of the study. Using applicable starting materials the silica sol was prepared at differing concentrations. For each sol prepared specific parameters were used to aid in the formation of a nanocoating that had specific properties and also to develop a controllable procedure which would allow the systematic modification of the substrate surface at nanoscale with pure silica sol. The dipcoating

technique was employed to coat silica wafers and analysis of the wafers was done using Infrared Spectroscopy and Atomic Force Microscopy

Morphological features of Carbon on 4H and 6H-SiC annealed at 1500°C

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Research Advisor: Dr. Lu, Tiffany Crenshaw

Abstract

Experimental conditions of carbon nanotube growth on SiC have been explored in this study. An atomic force microscope (AFM) has been used to observe the surface of the samples and we are only able to see the morphological features. Conductive-AFM was used to obtain electrical measurements on each sample. Each sample was created under different conditions with a constant temperature of 1500° C.

High Resolution Imaging of Prokaryotic Cells by Atomic Force Microscopy following Stress Induction: *Rhodospirillum rubrum*

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Ms. Tiffany Crenshaw and Dr. Weiye Lu

Abstract

The ability to produce high-resolution images of prokaryotic microorganisms under environmental stress will profoundly impact our current knowledge of microbial stress response mechanisms. An understanding of the relationship between environmental stress and biochemical responsiveness may pave the way for the development of ways to regulate genes in sporulating and nonsporulating bacteria. Also, this study may establish the utilization of advanced technology for microbial cell characterization. This analysis of *Rhodospirillum rubrum* is part of a larger investigation of prokaryotic microorganisms in which *Bacillus stearothermophilus* and *Micrococcus roseus* were also environmentally stressed. *Rhodospirillum rubrum* was stressed nutritionally and thermally. The results retrieved by atomic force microscopy showed changes in the surface morphology of these prokaryotic microorganisms attributed to the environmental stresses.