University off Puerto Rico at Humacao

1st Annual Meeting

November 18-19, 2004
Natural Sciences Building
UPR-Humacao

1st ANNUAL MEETING
Partnership for Research and Education in Materials

PROGRAM AND ABSTRACTS

November 18-19, 2004
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1st ANNUAL MEETING
Partnership for Research and Education in Materials

PROGRAM

Thursday, November 18, 2004

9:00- 9:30 am	Registration (coffee)
9:30- 10:00 am	Welcome
10:00- 11:00 pm	PREM Progress Report ▪ Idalia Ramos, PI UPR-H ▪ Ramón Rivera Ocasio, Educational Coordinator UPR-H ▪ Andrew McGuie, PENN
11:00- 12:00 pm	Research Teams Presentations ▪ 11:10-11:40 A. Guadalupe UPR-RP and E. Vega UPR-H ▪ 11:40-12:10 L. Blum UPR-RP, P. Moore USinP and M.L. Klein PENN
12:10- 1:15 pm	Lunch at UPR-H Cafeteria
1:30- 2:30 pm	Research Teams Presentations (Continuation) ▪ 1:30-2:00 W. Otaño UPR-C ▪ 2:00-2:30 J. Sotero UPR-H , A. Suresh PENN and J. Santiago PENN
2:30- 3:00 pm	Coffee Break
3:00- 4:00 pm	Research Teams Presentations (Continuation) ▪ 3:00-3:30 N. Zimbovskaya UPR-H ▪ 3:30- 4:00 P. Moore USinP
4:00-4:30pm	Visit Laboratories
4:30- 5:30 pm	Students Posters Session (Natural Science Building Hall)
5:30pm	Closing (Videoconference Room)

1st ANNUAL MEETING
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PROGRAM

Friday, November 19, 2004

9:00- 9:30 am	Registry (Coffee)
9:30- 10:30 am	Research Teams Presentations (Continuation) ▪ 9:30-9:50 N. Pinto UPR-H, A.T. Johnson PENN and A. MacDiarmid PENN ▪ 9:50- 10:10 R. Furlan UPR-H and J. Santiago PENN ▪ 10:10- 10:30 I. Ramos UPR-H and J. Santiago PENN
10:30- 11:30 am	Advisory Committee Meets to Write Report
11:30- 12:00 pm	Evaluation and Closing
12:00- 1:15 pm	Lunch
1:30 pm	Transportation from UPR-H to Old San Juan

FACULTY ORAL PRESENTATIONS

Esther Vega

DESIGN OF A DNA BIOSENSOR TO DETECT BACTERIA IN THE ENVIROMENT

Ana Guadalupe[1] and Esther Vega[2]

[1] Department of Chemistry, University of Puerto Rico at Rio Piedras
[2] Department of Biology, University of Puerto Rico at Humacao

The purpose of this project is to design an array DNA probe to detect fecal coliforms in water and *Salmonella* in foods. Two phases of this project are described in this work: the sequence design and the probe design. In terms of the sequence design we have been working designing short DNA sequences to detect *lacZ* and *lamB* for coliforms and *Hin*, *InvA*, *OmpC* and *Sdfl* for *Salmonella*. From twelve sequences design for coliforms, only six hybridize exclusively with coliforms. For *Salmonella*, preliminary work in terms of the design of these sequences indicates that these genes for *Salmonella* are important in the detection of these organisms as shown by PCR. However, the primers used in PCR were longer (21-mer). When shorter primers were designed to detect the target genes, although computer simulated hybridization indicates that the sequences were only able to hybridize with *Salmonella*, preliminary work in the laboratory indicated that the sequences tested are able to hybrize with DNA from other organisms. Other sequences will be tested to find those able to hybridize only with *Salmonella*. In terms of the probe design we have been able to detect by Osteryoung Square Wave Voltammetry the hybridization of Ferrocene and Ruthenium Oligonucleotides in the Probe Film. The probe was prepared when succimide ester-polysterene-succinimide ester 5% (w/v) in 1,1,2-trichloroethane was spin-coated over a gold substrate. The polymer films were immersed in the Am-oligonucletide solution (pH 9.6) and were left for 24 hours at 4 ^{0}C. Then the polymer films were rinsed with deionized water-PBS buffer-deionized water and were placed in a vacuum line overnight. Complementary DNA sequence to the oligonucleotide immobilized on the surface had been electrochemically labeled. We have been able to detect the hybridization between a 16-mer sequence for gene *lamb* and its complementary sequence specific for fecal coliforms, the detection ds-DNA for the gene *Hin* involve in the control of phase variation for *Salmonella* species and the detection of both sequence in the same hybridization event.

Lesser Blum

ANALYTICAL MODEL FOR TOROIDAL IONIC CHANNELS SCALING THEORY

L. Blum and A. Enriquez

Department of Physics, University of Puerto Rico at Río Piedras

Ionic channels are complex systems which are driven by electrostatic interactions. Understanding the permeation of ions through the channels is a challenging proposition because of the complexity of the system, in which we have the channel, the ions and the water: Simple yet robust theories are very useful in studying the influence of different parameters in the permeation problem.

A simple analytical solution of the linear Poisson-Boltzmann and the MSA equations was found for a model of an ionic channel consisting of a charged general torus. The results are encouraging as compared to Monte Carlo simulations. Several ways of improving this solution are suggested by the simulation results. The idea is always to interpolate between low density, high temperature and high density, low temperature situations, which are always known.

A recent member of the asymptotic state family is the water-glass: We have solved analytically this model for tetrahedral water. It yields excellent agreement with computer simulations and experimental structure functions for liquid water. This result coupled to the analytical channel theory makes it possible to study the behavior of ionic solutions in model channels.

Wilfredo Otaño

PHYSICAL VAPOR DEPOSITION OF BORON NITRIDE AND ALUMINUM NITRIDE: FROM THIN FILMS TO NANOSTRUCTURES

Wilfredo Otaño, Víctor M. Pantojas and Carlos Ortiz,

Department of Mathematics-Physics, University of Puerto Rico at Cayey

Boron nitride (BN) and aluminum nitride (AlN) are fascinating materials where the combination of structure, composition and bonding produces unique properties. Group III nitrides in general, and BN and AlN in particular, are important technological materials due to their mechanical, thermal and optical properties and their potential to be used in important electronic applications. Physical vapor deposition methods have been successful in the deposition of nitride thin films as s result of their flexibility to provide energetic bombardment to the growing film, while at the same time providing the necessary substrate temperature and chemistry. Resent efforts directed to control the characteristics-properties relationship of AlN and BN thin films will be presented. In particular, the effects of hyperthermal ion bombardment on growing films prepared by rf magnetron and ion beam assisted deposition systems will be discussed.

Another goal of our research group, in early stages of development, is the study of the relationship between the nanoscale crystalline dimensions of the BN and AlN thin films and important properties of these two materials. The synthesis of nanoscale BN and AlN is also being complemented with an exploration component for the formation of BN nanotubes and AlN nanorods using sputtering deposition techniques. Preliminary efforts in those directions will be presented.

José Sotero

SIMULATION OF FLUID FLOWS IN MEMS

José O. Sotero-Esteva[1], Wendell Rosado[1] and Jorge J. Santiago-Avilés[2]

[1]. Department of Mathematics, University of Puerto Rico at Humacao.
[2]. Department of Electrical and Systems Engineering, University of Pennsylvania.

The goal of our group is to study and ilustrate fluid flows in MEMS devices by means of numerical simulations. The simulations will provide information for scientific research as well as produce graphical and software material for PREM education and outreach efforts. It is well known that traditional models for macroscopic fluid flows based on Navier Stokes equations do not apply to micro-nano scales. For liquid flows, the increased importance of boundary conditions, surface tension gradients and hydrophobic or hydrophilic characteristics of the material have to be considered among others. In this work special attention will be given to interactions due to the porous nature of the ceramics (LTCC) used by other groups of the PREM project. Other researchers who work with LTCC have found a significant influence of these properties on wet fluid flows in mesosystems [1].Numerical methods for simulations in these scales may be divided into two main categories: discrete (atomistic) and continuum [2]. Discrete methods based on molecular dinamics can be combined with Monte Carlo methods to decrease their computational efficiency. But even with those improvements discrete methods are highly computationally intensive and may not be practical for flow simulation through an entire system. Continuum methods may be based on finite elements methods or meshless methods. They generally computationally efficient and easier to implement, specially with the use of simulation software such as ANSYS or other software libraries. But these methods may fail in complex geometries with abrupt turns. Therefore, efforts will be made to combine both approaches, using the continuum methods on regions were it can be safely used and discrete methods elsewere.

[1] Ibañez-García, N.; Alonso Camacho, J.; Mendes Rocha, Z.; Góngora-Rubio, M., **Wet Chemical Analysis Mesosystems by Means of (LTCC) – Green Ceramic Tape Technology**, Ibersensor 2004, October 2004, Puebla, Mexico (submitted to Acta Mexicana de Ciencia y Tecnología).

[2] Karniadakis, G.; Beskok, A, **Micro Flows Fundamentals and Simulation**, Springer Verlag Ed., 2002, ISBN 0-387-95324-8

Natalya A. Zimbovskaya

ON THE ELECTRONIC TRANSPORT IN CONDUCTING POLYMERIC WIRES

Natalya A. Zimbovskaya

Department of Physics, University of Puerto Rico at Humacao

Nonlinear current-voltage characteristics were recently observed in experiments on the electrical characterization of doped polyanine-based nanofibers. A theoretical analysis of the conductance in the polymeric nanofibers is presented. The analysis is based on the model of a granulated metal, so the polymeric material is treated as a network of metallic-like domains made out of densely packed polymeric chains embedded in amorphous array of disordered chains. Assuming the electronic transport to be provided by the electron tunneling between the metallic grains through the intermediate resonance states, the theory of conductance in molecular wires is employed to calculate the tunneling current. It is shown that nonlinear features in the I-V curves could appear when the coupling of the grains to the intermediate bridge state is weak enough. Obtained results are in agreement with the experiments.

Preston B. Moore

MOLECULAR DYNAMICS SIMULATION OF ION CHANNELS

Preston B. Moore

Department of Physics, University of the Sciences in Philadelphia

Membranes and integral membrane proteins are critical to life. However, the fundamental structure, dynamics and processes of these molecular structures are not fully understood. The seminar will present results from molecular dynamics simulations on membranes and membrane systems. Molecular dynamics simulations have been shown to be effective in our understanding of these complex systems, which is one of many computational chemistry methods that have become vital component of contemporary research. Results from different simulations demonstrating the types of structural and dynamics information that can be obtain from these calculations will be presented. Specifically, the simulation results will range from an idealized ion channel to an atomisticly detailed calculation. The idealized simulation includes the basic components of the ion channel such as ions, and a tube to represent the ion channel. The fully atomistic calculation consists of the VPU protein (which is a protein produced by the HIV-1 virus) which forms an ion-channel, embedded in a lipid bilayer.

Nicholas Pinto

PREPARATION AND ELECTRICAL CHARACTERIZATION OF CONDUCTING POLYMER NANOFIBERS, NANOTUBES AND MICROSPHERES

Nick Pinto[1], Alan G. MacDiarmid[2] and
Alan T. Johnson[3]

[1] Department of Physics, University of Puerto Rico at Humacao
[2] Department of Chemistry, University of Pennsylvania
[3] Department of Physics, University of Pennsylvania

A brief overview of the research projects undertaken under the CIRE program will be presented and include the electrospinning process to prepare polymer nanofibers and their characterization. A new method of preparing doped polyaniline nanotubes and microspheres will be discussed. Electrical resistance of pressed pellets of the polymer were measured as a function of temperature and compared to the resistance of thin films made of the same polymer. We will also present preliminary results on field effect transistors (FET) based on pentacene thin films. Our goal is to be able to prepare nanofibers of this material via electrospinning for use in one dimensional organic FET's.

Rogerio Furlan

STUDY OF MICROFLUIDIC OSCILLATORS

Rogerio Furlan[1], Idalia Ramos[1], and
Jorge J. Santiago-Avilés[2]

[1] Department of Physics, University of Puerto Rico at Humacao
[2] Department of Electrical and Systems Engineering, University of Pennsylvania

In this research we are developing fabrication methods and monitoring the performance of microfluidic oscillators. These devices are formed by microchannels with rectangular cross sections and contain one input (supply) and two outputs ports. Part of the output flow (gas or liquid) is injected to control inputs (using feedback channels). This feedback causes the movement (oscillation) of the main flow inside the structure. These devices have been used in our group as sensors and actuators. Different types of structures have been defined in PMMA (Lucite) using a CNC milling machine, thick photoresist (SU-8), green tape (LTCC, Dupont) using micromolding, and in quartz substrate and sintered LTCC using thermal laser milling. For operation with different types of gases we observed that the typical variation of the frequency with volumetric flow presents a range close to thousands of Hz. Also, we found indication of a possible second order dependence of the oscillation frequency with the viscosity for different types of fluids (including liquids), an effect that is under investigation.

Idalia Ramos

ELECTROSPUN TIN OXIDE NANOFIBERS

Idalia Ramos[1], Rogerio Furlan[1], Nicholas J. Pinto[1], Jorge Santiago-Avilés[2]

[1] Department of Physics, University of Puerto Rico at Humacao
[2] Department of Electrical and Systems Engineering, University of Pennsylvania

Ultrafine tin oxide (SnO2) fibers in the rutile structure, with diameter ranging from 100nm to several microns, were synthesized using electrospinning and metallorganic decomposition techniques. Fibers were electrospun using two different precursor solutions. The first is a mixture of mixture of pure SnO_2 sol made from $SnCl_4$: H_2O : C_3H_7OH : 2-C_3H_7OH at a molar ratio of 1:9:9:6, and a viscous solution made from poly(ethylene oxide) (PEO) and chloroform $CHCl_3$ at a ratio of 200mg PEO/10mL $CHCl_3$. The second solution contains Dimethyldineodecanoate Tin $C_{22}H_{44}Sn$ and a viscous solution made from 100mg PEO/$CHCl_3$. The as deposited fibers were sintered at 400, 500, 600, 700 and 800°C in air for two hours. Scanning electron microscopy (SEM), Scanning probe microscopy (SPM), X-ray diffraction (XRD), Raman microspectrometry and x-ray photoelectron spectroscopy (XPS) were used to characterize the sintered fibers and elucidate the chemical reaction during sintering. The results showed that up to the sintering temperature of 700°C, the synthesized fibers are composed of SnO_2. X rays photoelectron spectroscopy was found to reflect the complicate chemical changes caused by the sintering process. The results showed that the fibers are composed of SnO_2 and that the $SnCl_4$ precursor led to better results in terms of uniformity/continuity of the fibers.

POSTER PRESENTATIONS

P1

STUDY OF LASER MILLING OF SINTERED LTCC AND QUARTZ SUBSTRATES FOR MICROFLUIDIC APPLICATIONS

Miguel Perez Tolentino[1]
Mentors: Rogerio Furlan[1], Idalia Ramos[1], and Jorge J. Santiago-Avilés[2]

[1] Department of Physics, University of Puerto Rico at Humacao
[2] Department of Electrical and Systems Engineering, University of Pennsylvania

There are many microstructures with no moving parts that can be defined using sealed microchannels/microcavities. For example, we are interested in the development of microfluidic oscillators to be used as sensors and actuators. The definition of this type of structure in a substrate by means of laser milling represents a simple and fast process for applications that require critical dimensions of hundreds of microns. Thus, in this work we explored the use of this technique to obtain microfluidic oscillators in quartz and sintered LTCC (DuPont 951AT) substrates. The characteristics of the obtained microchannels were analyzed in terms of depth, profile, and defects. Laser milling was performed through an X-660 Laser Platform (Universal Laser Systems, 60 W CO_2 laser, wave length of 10.6 µm) operating in the raster mode. The samples were analyzed by using a profilometer and an optical microscope. Practical structures with microchannels with depths of more than 100 µm were obtained in tens of seconds. For a same power and laser speed the microchannels milled in quartz substrates resulted deeper and could be defined without defects on the bottom (cracks). These defects, caused by thermal stress were observed for all samples milled in sintered LTCC.

P2

SEALING AND TESTS OF MICROFLUIDIC OSCILLATORS IMPLEMENTED IN TRANSPARENT SUBSTRATES

Jose Manuel Castillo Colon[1] and Josean Paulino Sustache[1]
Mentors: Rogerio Furlan[1], Idalia Ramos[1], and Jorge J. Santiago-Avilés[2]

[1] Department of Physics, University of Puerto Rico at Humacao
[2] Department of Electrical and Systems Engineering, University of Pennsylvania

In this project we are investigating the sealing and performance of microfluidic oscillators fabricated in transparent substrates. Microfluidic oscillators are devices formed with microchannels that can be used as sensors and actuators. These microfluidic oscillator structures were defined directly on quartz substrates using thermal laser milling or in thick photoresist (SU-8) applied on quartz substrates. The sealing is been studied using transparent thermal adhesive. A test apparatus has been defined using interconnection tubes, a syringe pump and an optical microscope. Tests with alcohol and water based solutions containing microparticles of graphite are being performed.

P3

ANALYTICAL MODEL FOR TOROIDAL IONIC CHANNELS

Results of the Monte Carlo simulations and comparison to the theory in talk

Department of Physics, University of Puerto Rico at Rio Piedras

Ionic channels are complex systems which are driven by electrostatic interactions. Understanding the permeation of ions through the channels is a challenging proposition because of the complexity of the system, in which we have the channel, the ions and the water: Simple yet robust theories are very useful in studying the influence of different parameters in the permeation problem.

A simple analytical solution of the linear Poisson-Boltzmann and the MSA equations was found for a model of an ionic channel consisting of a charged general torus. The results are encouraging as compared to Monte Carlo simulations. Several ways of improving this solution are suggested by the simulation results. The idea is always to interpolate between low density, high temperature and high density, low temperature situations, which are always known.

A recent member of the asymptotic state family is the water-glass: We have solved analytically this model for tetrahedral water. It yields excellent agreement with computer simulations and experimental structure functions for liquid water. This result coupled to the analytical channel theory makes it possible to study the behavior of ionic solutions in model channels.

P4

DIELECTRIC PROPERTIES OF $Rb_{1-x}(NH_4)_xH_2PO_4$ (RADP) AS A FUNCTION OF TEMPERATURE

Rosana González
Mentor: N. Pinto

Department of Physics, University of Puerto Rico at Humacao

The scope of the work is to investigate the dielectric properties of mixed Rubidium Dihydrogen Phosphate (RDP)/Ammonium Dihydrogen Phosphate (ADP) single crystals. RDP is a ferroelectric material with the ferroelectric transition temperature T_c = 146K and ADP is an anti-ferroelectric material with a transition temperature of T_n = 147K. The phase transition in RDP is believed to be continuous while the phase temperature in ADP is strongly first order.

Slow evaporation at room temperature was the method that we used to prepare mixed single crystals of $Rb_{1-x}(NH_4)_xH_2PO_4$ from an aqueous solution containing different RbH_2PO_4 (RDP) and $(NH_4)H_2PO_4$ (ADP) concentrations. The concentrations of ADP studied were x = 0.00, x = 0.12 and x = 0.20. The crystals had tetragonal symmetry with $\mathbf{a} = \mathbf{b} \neq \mathbf{c}$ and where **c** is the ferroelectric/anti-ferroelectric axis. The crystals were cut and polished along the crystallographic **a** and **c** axes. Silver metal was vacuum deposited on the polished surfaces of the crystal and electrical contacts were made with gold wire and silver paint. The crystal was then placed in a closed cycle Helium refrigerator and connected to a HP Impedance Analyzer. We present the dielectric properties of RADP as a function of temperature. Our results consist of (1) Polarization as a function of temperature, (2) Dielectric Permittivity ($\varepsilon' - i\varepsilon''$) as a function of temperature, (3) Hysteresis loops as a function of temperature.

P5

PREPARATION AND ELECTRICAL CHARACTERIZATION OF POLYANILINE NANOFIBERS, NANOTUBES AND NANOSPHERES

A. M. Ayala[1], P. Carrión[2]
Mentors: M. Ortiz[1], N. J. Pinto[2] and A.G. MacDiarmid[3]

[1]*Department of Chemistry*, University of Puerto Rico at Humacao
[2]*Department of Physics*, University of Puerto Rico at Humacao
[3]*Department of Chemistry*, University of Pennsylvania

We report on the preparation and electrical characterization of doped polyaniline nanofibers, nanotubes and nanospheres. These nanostructures of polyaniline were prepared via a template free method of synthesis. Hollow polyaniline (PANi) nanotubes doped with 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPSA) have been synthesized and their electrical resistance measured as a function of temperature. The average length of the nanotubes was in the range 2 μm – 5 μm and the average diameter was in the range 200 nm – 400 nm. Current voltage (I-V) measurements were made as a function of temperature of PANi doped with camphorsulfonic acid (CSA) and 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPSA) prepared using the method mentioned above. While the conductivity of AMPSA doped PANi was slightly higher the conduction mechanisms were similar. The polymer synthesis temperature was important in obtaining smaller diameter and longer length fibers. Longer reaction times did not affect the morphology of the nanotubes. Microspheres of polyaniline were also prepared using salicyclic acid as the dopant.

P6

DEVELOPMENT OF A DNA SENSOR USING PEPTIDE NUCLEIC ACID (PNA) AS A PROBE ATTACHED TO POLYSTYRENE FILMS

Rocío del A. Cardona and Lisa Muñoz
Mentor: Ana Guadalupe

Department of Chemistry, University of Puerto Rico at Rio Piedras

The need for fast detection of harmful bacteria and other pathogens has leaded the scientific community to study new sensor probes and devices. Peptide Nucleic Acid (PNA), a DNA synthetic analog, is a new tool in nucleic acid research. This molecule posses many of DNA properties but also present promising features because of its capacity to form more rigid structures, better hybridization and to detect bases mismatches. Due to its properties PNA has been used as a probe in the construction of DNA biosensors.

In our research, thin films of polystyrene functionalized with succinimide were prepared over gold substrates. PNA chains modified with amino groups were immobilized in the polymer surface. The complementary DNA sequence for PNA was labeled with a ferrocene complex. The hybridization was monitored by the redox process of ferrocene using Osteryoung Square Wave Voltammetry (OSWV). Atomic Force Microscopy (AFM) and X-Ray Photoelectron Spectroscopy (XPS) were used to determine morphology changes after immobilization and hybridization. The electrochemical studies showed that the response time for double strand formation were around 60 min. Using AFM and XPS the formation of the double strand was also confirmed after changes in surface morphology and elemental analysis, respectively. To complete the development of our DNA/PNA sensor a calibration curve will be constructed to evaluate the analytical characteristics of this sensor.

P7

DESIGN OF SHORT DNA OLIGONUCLEOTIDES TO DETECT SALMONELLA

Carly Carrión, Josiel Medina
Mentor: Esther Vega

Department of Mathematics, University of Puerto Rico at Humacao

The purpose of this project is to design an array DNA probe to detect *Salmonella* in foods. We have been working designing short DNA sequences to detect *Hin*, *InvA*, *OmpC* and *Sdfl* for *Salmonella*. Preliminary work in terms of the design of these sequences indicates that these genes for *Salmonella* are important in the detection of these organisms as shown by PCR. However, the primers used in PCR were longer (21-mer). When shorter primers were design to detect the target genes, although computer simulated hybridization indicates that the sequences were only able to hybridize with *Salmonella*, preliminary work in the laboratory indicated that the sequences tested are able to hybrize with DNA from other organisms. Other sequences will be tested to find those able to hybridize only with *Salmonella*.

P8

TIN OXIDE NANOFIBERS ELECTROSPUN USING A $SnCl_4$ PRECURSOR SOLUTION

Neliza León[1], Glendalys Figueroa[1] and Anamaris Meléndez[1]
Mentors: Idalia Ramos[1], Rogelio Furlan[1], Nicholas Pinto[1], Jorge J. Santiago-Avilés[2]

[1] Department of Physics, University of Puerto Rico at Humacao
[2] Department of Electrical and Systems Engineering, University of Pennsylvania

Ultrafine tin oxide (SnO2) fibers in the rutile structure, with diameter ranging from 100nm to several microns, were synthesized using electrospinning and a precursor solution which is a mixture of pure SnO2 sol made from SnCl4 : H2O : C3H7OH : 2-C3H7OH at a molar ratio of 1:9:9:6, and a viscous solution made from poly(ethylene oxide) (PEO) (molecular weight 900,000) and chloroform CHCl3 at a ratio of 200mg PEO/10mL CHCl3. This solution allows obtaining an appropriate viscosity for the electrospinning process. The as deposited fibers were sintered at 400, 500, 600, and 700°C in air for two hours and were characterized using Scanning Electron Microscopy (SEM), X-ray diffraction (XRD), Raman microspectrometry and x-ray photoelectron spectroscopy (XPS). The results showed that up to the sintering temperature of 700°C, the synthesized fibers are composed of SnO_2.

P9

ELECTROCHEMICAL SYNTHESIS AND PHYSICOCHEMICAL CHARACTERIZATION OF GOLD-COVERED POROUS SILICON µ-WELLS

Mariem Rosario-Canales[1] and Maritere Rivera Sánchez[1]
Mentors: Ana R. Guadalupe[1], and Luis F. Fonseca[2]

[1]University of Puerto Rico, Río Piedras Campus, Department of Chemistry.
[2]University of Puerto Rico, Río Piedras Campus, Department of Physics.

Our research focuses on the use of porous silicon (PSi) micro- and nanostructured surfaces for applications in the production of cost-effective electrochemical sensors and arrays. We report on the preparation and morphological characterization of PSi structures grown in sodium fluoride (NaF) aqueous solutions, and the subsequent gold sputtering and electrochemical studies of these porous surfaces. The PSi samples were prepared by standard electrochemical etching of <100>, p-type crystalline silicon wafers with a resistivity of 20-30 Ω·cm that contained an aluminum contact on the back side. Scanning electron microscopy (SEM) analyses revealed morphologies consisting of a high-density array of micron-sized wells or macroporous networks. Because we have previously demonstrated through surface characterization techniques that the porous framework is covered with a silicon dioxide layer, it is necessary to cover the surfaces with a gold layer to make them conductive. Thus, the PSi substrates were submitted to gold sputtering and electrochemical characterization was done using the techniques cyclic voltammetry (CV) and chronocoulometry (CC). For CV, the electroactive probe was ferrocene carboxylic acid (Fc-COOH) in phosphate buffer at pH 6.98. Results indicated that the Fc-COOH redox process was diffusion controlled and data obtained at various scan rates showed resistance to electron transfer. CC studies were done in aqueous and organic media to determine the active area of the gold-covered porous electrodes. Ongoing and future work with the PSi surfaces includes high-resolution transmission electron microscopy characterization and their exploitation for the development of electrochemical sensor arrays.

P10

FIELD EFFECT TRANSISTORS BASED ON PENTACENE

Pedro L. Carrión Morant[1]
Mentors: Nicholas J. Pinto[1], Alan T. Johnson[2]

[1] Department of Physics and Electronics, University of Puerto Rico at Humacao
[2] Department of Physics, University of Pennsylvania

We present our results on the field effect transistor behavior of pentacene. We have used doped Si-SiO_2 wafers and also varnish coated copper wires as the substrate and gate electrode. Pentacene was vacuum deposited over these substrates to form the source drain active semiconductive layer. In addition, we have electrospun polystyrene fibers, and then we have coated the fibers with pentacene and placed them on a pre-patterned silicon substrate in a field effect transistor configuration. The purpose of this study was to familiarize ourselves in the fabrication and testing of field effect transistors based on pentacene. Our final goal is to be able to fabricate field effect transistors based on pentacene nanofibers.

P11

STUDY OF THE INTERACTION OF POLYCATIONS WITH AN 18-MER DNA SEQUENCE

Fernando González, Rocío Cardona and José N. Carrasquillo
Mentor: Ana R. Guadalupe

Department of Chemistry, University of Puerto Rico at Rio Piedras

Detection of *Escherichia coli* 0157:H7 has been of great concern for the quality control of food and pharmaceutical products. Different detection systems had been used for detection pathogens but many are slow, costly and not user-friendly analyses. Thus, the development of electrochemical biosensors offer a fast, cheap and easy-to-use alternative for the detection of pathogens, specially when quality assurance methods are required for the fast release of safe products to the market. Electroactive polycations of poly (vinylferrocene-co-4-vinylpyridine) in a 25%vfc/75%4-vpy ratio, quaternized with methyl, ethyl or propyl iodide were used as electroactive labels for the detection of the 18-mer DNA sequence (ds-LMB1) formed by the oligonucleotide ss-LMB1P (5'- CTA TGC ACG TTC CGG TAT- 3') and its complementary sequence (ss-LMB1C). The detection of the ds-DNA was based on the electrostatic interaction between the negatively charged phosphates of the DNA and the polycations, forming an interpolyelectrolyte complex (IPEC). The binding studies, which were performed by Osteryoung square wave voltammetry (OSWV), showed binding constants in the range of 10^6 M^{-1}. The results show that increase in quaternizing agent aliphatic chain decrease the binding strength of IPECs, but not significantly. In conclusion, polycations are good electrochemical labels for the detection of target DNA sequences, which could be the basis for the development of electrochemical biosensors for the detection of E. *coli* 0157:H7. required for the fast release of safe products to the market. Electroactive polycations of poly (vinylferrocene-co-4-vinylpyridine) in a 25%vfc/75%4-vpy ratio, quaternized with methyl, ethyl or propyl iodide were used as electroactive labels for the detection of the 18-mer DNA sequence (ds-LMB1) formed by the oligonucleotide ss-LMB1P (5'- CTA TGC ACG TTC CGG TAT- 3') and its complementary

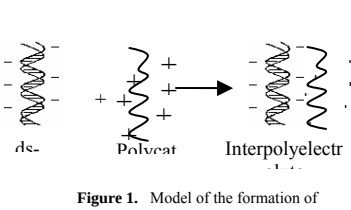

Figure 1. Model of the formation of IPECs

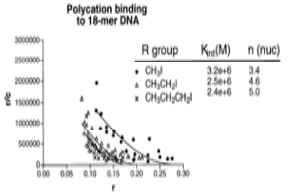

Figure 2. Scatchard Plots results from the binding studies of the polycations with the 18-mer DNA.

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SIMULATION OF FLUID MIXING IN MICROCHANNELS

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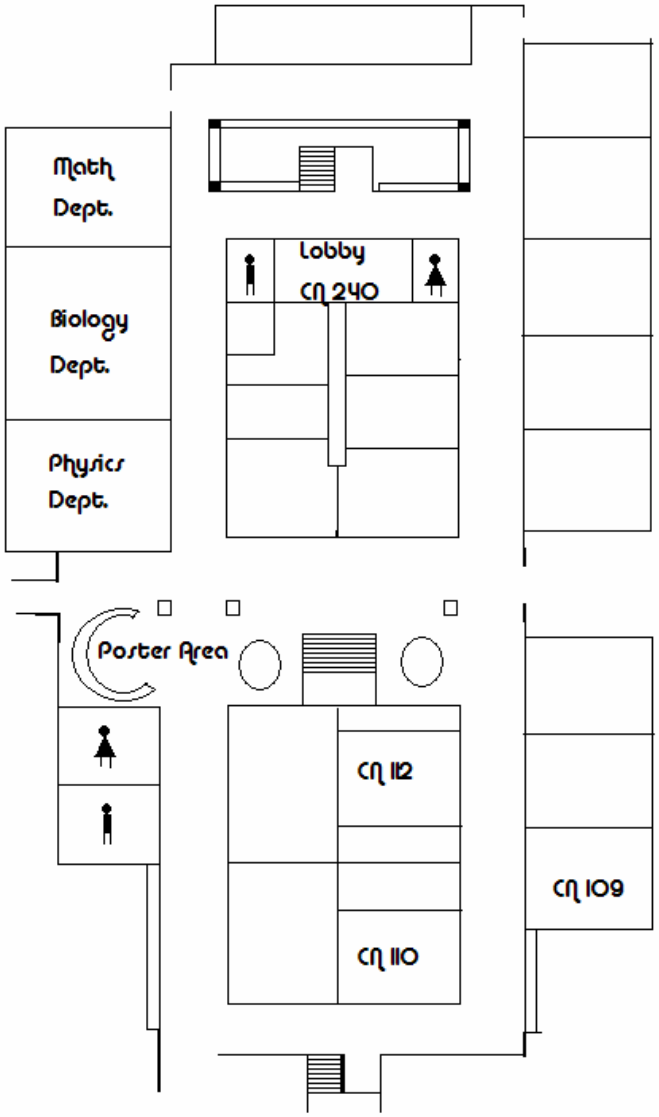
We discuss our implementation of a simulation of Fluids in Macrochannels. This implementation uses a program called FreeFem. The way that the fluids respond depends in the pressure that is given in the starting point of the macrochannel. A 2D version of the simulation is currently completed. Creating an algorithm that resembles the way that fluids respond in a microscopic environments, better graphics, conversion to ANSIS and C++, and extension to 3D models will be added.



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