MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Camp Summer Student Projects 2012

CHARACTERIZATION OF TAU-MEDIATED MICROTUBULE ASSEMBLY

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Ekenechukwu Akabike Biology	Peter Chung	Cyrus Safinya	Materials

EQUIPMENT FOR THE ATOMIZATION OF A LIQUID DROPLET BY AN ELECTROMAGNETIC SHOCK WAVE

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Fernando Corona Mechanical Engineering	A. Cazabat H. Mayer	R. Krechetnikov	Mechanical Engineering

ANALYZING THERMAL PERFORMANCE OF THE UCSB OCEAN SCIENCE EDUCATION BUILDING USING THEORETICAL METHODS

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Ruben Diaz Mechanical Engineering	Michael Georgescu	Igor Mezic	Mechanical Engineering

MODEL-BASED RECOMMISSIONING ANALYSIS FOR THE ENERGY USAGE OF THE STUDENT HEALTH BUILDING, UNIVERSITY OF CALIFORNIA, SANTA BARBARA

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Patricia Gomez Mechanical Engineering		Bryan Eisenhower	Mechanical Engineering

RNAI SUPPRESSES GENE EXPRESSION IN ROUNDWORMS TO INHIBIT THEIR RESPONSE TO CHEMOTAXIS

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Amanda Henry Biochemistry	Tim Lynch	Joel Rothman	Cellular, Molecular and Developmental Biology

THERMOCOUPLE SLIP RING ASSEMBLY FOR HIGH TEMPERATURE MEASUREMENTS IN ELECTRON BEAM PHYSICAL VAPOR DEPOSITION PROCESSING CHAMBER

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Damian Leon Mechanical Engineering	Chris Nunez Deryck Stave	Carlos G. Levi	Materials

LAYOUT IMPACT ON VeSFET BASE SRAM DESIGN: CREATING A BETTER TRANSISTOR

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Jorge Padilla Electrical Engineering	Xiang Qiu	Malgorzata Marek-Sadowska	Electrical and Computer Engineering

THE SEQUENCE OF A GENOME REARRANGEMENT SITE ON MICRONUCLEAR CHROMOSOME 1 OF TETRAHYMENA THERMOPHILA

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Reynal Palafox Rosas Cell and Developmental Biology	Eileen Hamilton	Eduardo Orias	Cellular, Molecular and Developmental Biology

MULTIPLE CORRELATING CAPTURE OF FLARE EMISSIONS AT ALTITUDE

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Jonnathan Terry Computer Engineering	Jon Suen	Philip Lubin	Physics

IMPROVING THE EFFICIENCY OF ORGANIC PHOTOVOLTAICS: MANIPULATION OF THE ELECTRON DONATING POLYMER

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Preston Washington Biochemistry	Fulvio Brunetti	Craig Hawker	Materials

POTENTIAL FOR MICROBIAL CONSUMPTION OF MARINE HYDROCARBONS

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Christian Perez Chemical Engineering	Stephanie Mendes	David Valentine	Earth Science

OPEN SOURCE PRIVATE CLOUD FILE-SYSTEM

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Jocelyn Ramirez Electrical Engineering		Chandra Krintz	Computer Science

STABLE ISOTOPE RATIO OF 13C/12C AS INDICATORS OF MICROBIAL CONSUMPTION OF HYDROCARBONS FROM NATURAL MARINE SEEPS

Student	Mentor(s):	Faculty Sponsor(s)	Department(s):
Rachel Scarlett Hydrology	Stephanie Mendes	David Valentine	Earth Science

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Ekenechukwu Akabike

Major: Biology

Mentor(s): Peter Chung

Faculty Sponsor(s): Cyrus Safinya

Faculty Sponsor's Department(s):
Materials

Project Title: CHARACTERIZATION OF TAU-MEDIATED MICROTUBULE ASSEMBLY

Project Description:
In humans, brain connections are usually strengthened using a microtubule-associated protein called Tau, but that function diminishes with old age. Aging may cause disruption of normal physiological processes and create a disease such as Alzheimer's as a direct result. Understanding the characteristics of Tau is important as it is implicated in neurofibrillary tangles, one of the main symptoms of Alzheimer's disease. Our interests delve into understanding the relationship between Tau and microtubules in order to know the role Tau's shape and function have during its interactions with microtubules. Characterization of Tau may provide insight on how adjustment of its form can prevent symptoms of Alzheimer's disease. This project examines the traits of a newly made type of Tau and endeavors to understand the traits of the protein by expressing segments of it and comparing the microtubule interactions. Assays have determined the binding affinity of certain Tau constructs thought to have physiological relevance, and microscopy visualized and compared assembled Tau-mediated microtubule bundles for differences in formation. Results show that Tau is important in the microtubule assembly process, and that it is necessary in neuronal expression. These results justify extensive comparison amongst many variants of Tau to determine which form exceeds the current benchmark of the microtubule assembly processes.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Fernando Corona

Major: Mechanical Engineering

Mentor(s): A. Cazabat
H. Mayer

Faculty Sponsor(s): R. Krechetnikov

Faculty Sponsor's Department(s):
Mechanical Engineering

Project Title: EQUIPMENT FOR THE ATOMIZATION OF A LIQUID DROPLET BY AN ELECTROMAGNETIC SHOCK WAVE

Project Description:
In this study we build tools that can be applied toward fundamental fluid mechanics research and will be necessary in the near future for experiments involving the atomization of a liquid droplet by an electromagnetic shockwave. To capture this phenomenon of atomization, we will also build a camera triggering unit capable of taking high-resolution photos in microseconds. In order to produce the shockwave for atomization, it is necessary that we fabricate two devices: a Triggered High Voltage Unit (THVU) and an Electromagnetic Shock Wave Generator (ESWG). Contained in the THVU are high-voltage components that serve as a high-energy source, while the ESWG contains conductive materials, specifically a copper spiral coil and an aluminum membrane, located above the coil. Current discharged from a capacitor within the THVU passes through the spiral coil and induces a magnetic field on the membrane. The interaction of the magnetic fields from the spiral coil and the membrane cause the membrane to deflect. This nearly instantaneous deflection ultimately atomizes a droplet placed on the surface of the membrane. As the capacitor discharges, a sensor detects the magnetic field around the current carrying wire, and supplies a signal to a delay unit. Varying the time delay from the delay unit is vital in transmitting the voltage signal to trigger the camera in order to photograph the high-speed atomization. Herein we report our progress towards the design and fabrication of the Triggered High Voltage Unit, Electromagnetic Shock Wave Generator, and camera triggering unit.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Ruben Diaz

Major: Mechanical Engineering

Mentor(s): Michael Georgescu

Faculty Sponsor(s): Igor Mezic

Faculty Sponsor's Department(s):
Mechanical Engineering

Project Title:
ANALYZING THERMAL PERFORMANCE OF THE UCSB OCEAN SCIENCE EDUCATION BUILDING USING THEORETICAL METHODS

Project Description:
An emerging goal of modern building design is the construction of buildings that provide comfort to occupants while consuming a minimal amount of energy. Reducing energy consumption and achieving comfort are competing factors in building operation, but with the increasing sophistication of building energy models (BEM), capable of simulating the thermodynamic behavior of a building and predicting energy consumption, these goals can be realized. Although models are a good predictor of building performance, numerous approximations must be made during their creation which may negatively affect accuracy. One such approximation is that of zoning, which is how the volume of a building is divided into regions where properties are assumed to be uniform. Zoning is practiced because it minimizes the time needed in creating a BEM and also requires less computation time to fully simulate. This process is often performed cut-and-try by the practitioner of the building model. A systematic approach for creating simplified models is presented using the Koopman Operator, a linear, infinite dimensional operator that captures nonlinear, finite dimensional dynamics without linearization. Using properties of the operator, modes of temperature oscillation can be identified using the predictions produced by a building model. These modes identify temperature behavior occurring at different time scales. From these modes, systematic approximations to the zoning can be created. An implementation of this technique is illustrated in a model of the Ocean Science Education Building at the University of California, Santa Barbara currently under construction, designed with both mechanical and natural conditioning.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Patricia Gomez

Major: Mechanical Engineering

Faculty Sponsor(s): Bryan Eisenhower

Faculty Sponsor's Department(s):
Mechanical Engineering

Project Title:
MODEL-BASED RECOMMISSIONING ANALYSIS FOR THE ENERGY USAGE OF THE STUDENT HEALTH BUILDING, UNIVERSITY OF CALIFORNIA, SANTA BARBARA

Project Description:
In the United States buildings account for 40% of our nation's energy which is twice as much as automobiles. Half of this energy is consumed by the heating, ventilation, and air conditioning systems (HVAC). Reducing the building's energy consumption will not only reduce the energy cost, but also consume fewer natural resources. With the United States facing high energy prices due to increased dependence on limited natural resources, it is important to reduce the unnecessary energy consumption in buildings. The Student Health Building on the University of California, Santa Barbara campus was built in the late 1960s and currently has an HVAC system that is managed and controlled inefficiently, costing the university approximately $147,000 each year. Correcting this inefficiency requires a greater understanding of the building's thermodynamics. An energy model of the building enables the understanding of these thermodynamics, and how occupants, weather, and equipment influence the energy performance of the building. In this study, computer model simulations will be used to test alternative control strategies to help reduce energy consumption while maintaining occupant comfort. The analysis primarily focuses on the components responsible for controlling the building's temperature. We envision that changing the control strategy for the HVAC in the building will ultimately lead to 10-20% energy usage reduction.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Amanda Henry

Major: Biochemistry

Mentor(s): Tim Lynch

Faculty Sponsor(s): Joel Rothman

Faculty Sponsor's Department(s):
Cellular, Molecular and Developmental Biology

Project Title: RNAI SUPPRESSES GENE EXPRESSION IN ROUNDWORMS TO INHIBIT THEIR RESPONSE TO CHEMOTAXIS

Project Description:
The Caenorhabditis elegan, a roundworm commonly used as a model organism in biology, lacks a complete analysis of its genome. Although many of its genes have been sequenced, not all of its genes are associated with a phenotype, leaving challenges in research for this organism. Some of the C. elegans' genome is dedicated to its sensory system, and once understood may allow for insight on more complex sensory systems, such as the mammalian sensory system. An abundance of research has been conducted on C. elegans regarding their sensory system, specifically, their ability to chemosense the environment around them. In this study, we test the ability of C. elegans to chemosense diacetyl, a byproduct produced by their natural food source, to determine if certain genes play a role in chemotaxis. Repressing genes with RNA interference has enabled us to determine if certain genes have a role in C. elegans' ability to detect diacetyl. Application of this strategy has shown several genes, previously unassociated with chemotaxis, to have an effect on the C. elegan sensory system. Furthermore, we plan to attain more information on these genes by testing C. elegan response to other volatile attractants.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Damian Leon

Major: Mechanical Engineering

Mentor(s): Chris Nunez
Deryck Stave

Faculty Sponsor(s): Carlos G. Levi

Faculty Sponsor's Department(s):
Materials

Project Title:
THERMOCOUPLE SLIP RING ASSEMBLY FOR HIGH TEMPERATURE MEASUREMENTS IN ELECTRON BEAM PHYSICAL VAPOR DEPOSITION PROCESSING CHAMBER

Project Description:
Thermal barrier coatings (TBCs) increase the thermal capability and enhance efficiency of gas turbines and jet engines. Their industrial and commercial importance has motivated researchers to investigate more effective material compositions. Extensive research has been conducted at UC Santa Barbara on TBC's applied to substrates via electron beam physical vapor deposition (EB/PVD). Characterization of new TBC's depends on many factors, including temperature of deposition. Current temperature measurement technology implemented at UCSB uses a stationary thermocouple to take an average temperature of the chamber and is insufficiently accurate when reporting the temperature of the substrate. The two main difficulties are the substrates necessity to continuously spin to attain a uniform coating and the high operating temperatures during the EB/PVD process. Herein we report our efforts towards the design and fabrication of a thermocouple slip ring assembly that will allow accurate temperature measurements to be taken in the EB/PVD chamber. A customized slip ring will be made using macor, a machinable ceramic with low electrical conductivity and low thermal expansion coefficient. Completion of the project will allow researchers to gain valuable information advancing their search for an optimal TBC.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Jorge Padilla

Major: Electrical Engineering

Mentor(s): Xiang Qiu

Faculty Sponsor(s): Malgorzata Marek-Sadowska

Faculty Sponsor's Department(s):
Electrical and Computer Engineering

Project Title: LAYOUT IMPACT ON VeSFET BASE SRAM DESIGN: CREATING A BETTER TRANSISTOR

Project Description:
The mainstream of today's semiconductor industry is based on bulk-Complementary Metal-Oxide-Semiconductor (CMOS) technology; however, bulk-CMOS technology will eventually run out of stream due to difficulties in scaling. A novel twin-gate transistor—**Ve**rtical **S**lit **F**ield **E**ffect **T**ransistor (VeSFET) may be an alternative. VeSFET transistors are organized into arrays (canvases) and circuits are implemented by configuring metal wires. Herein, we investigate the pros and cons of two VeSFET canvases—*basic canvas* and *chain canvas* for Static Random Access Memory (SRAM) design. We extract the parasitic capacitance for different SRAM cell layouts and study the capacitance impact on the performance and robustness of the SRAM by HSPICE simulation. The simulation results show that chain canvas based design will have an improvement in access time and an improvement in noise margin than a basic canvas based design. However, the footprint area of the chain canvas based design is much greater.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Reynal Palafox Rosas

Major: Cell and Developmental Biology

Mentor(s): Eileen Hamilton

Faculty Sponsor(s): Eduardo Orias

Faculty Sponsor's Department(s):
Cellular, Molecular and Developmental Biology

Project Title:
THE SEQUENCE OF A GENOME REARRANGEMENT SITE ON MICRONUCLEAR CHROMOSOME 1 OF TETRAHYMENA THERMOPHILA

Project Description:
Tetrahymena thermophila, a single-celled ciliate, is a model organism used for studying eukaryote cell processes. The somatic and germline genomes of this organism are separated into two different nuclei. The germline micronucleus (MIC) gives rise to the somatic macronucleus (MAC). Genome rearrangements occur during macronuclear differentiation; similar events have been observed in other ciliates as well as in humans. The MIC of *Tetrahymena* has been sequenced but not finished; the sequence remains incomplete. We sequenced the MIC region involved in one genome rearrangement, using polymerase chain reaction to amplify micronuclear DNA fragments from this region, then cloning and sequencing them. These new sequences were used to correct and finish this region of the MIC sequence assembly. Further, polymorphisms between the two inbred strains of *Tetrahymena* used for genetic mapping studies were discovered. The complete and corrected sequence of this region will facilitate an understanding of the mechanism of these genome rearrangement events in eukaryotes.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Jonnathan Terry

Major: Computer Engineering

Mentor(s): Jon Suen

Faculty Sponsor(s): Philip Lubin

Faculty Sponsor's Department(s):
Physics

Project Title: MULTIPLE CORRELATING CAPTURE OF FLARE EMISSIONS AT ALTITUDE

Project Description:
The sun emits radiation from solar flares at Terahertz frequencies. This recently discovered type of radiation is different from other types of solar radiation such as ultraviolet rays and microwaves that have been studied more extensively. Understand more about solar flares will help us learn about the changes in the sun's magnetic field and thus the earth's magnetic field as well. In order to better capture and understand solar flares, we have built a pointing system that specifically reads Terahertz radiation and works most effectively when pointing directly at the sun. However, because the majority of this radiation is trapped by atmospheric water vapor, we will suspend the pointing system on a platform attached to a weather balloon to a height of 120,000 feet above the earth's surface. At this altitude the pointing instrument can read the wavelengths of radiation and acquire data to be analyzed. We hope to use this information to learn more about the changes in the magnetic field of the sun and how it affects the earth's magnetic field and the energy we get from the sun.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Preston Washington

Major: Biochemistry

Mentor(s): Fulvio Brunetti

Faculty Sponsor(s): Craig Hawker

Faculty Sponsor's Department(s):
Materials

Project Title:
IMPROVING THE EFFICIENCY OF ORGANIC PHOTOVOLTAICS: MANIPULATION OF THE ELECTRON DONATING POLYMER

Project Description:
The world relies primarily on non-renewable fossil fuels for energy and particularly, the United States alone burns 900 million tons of coal a year. While we consume approximately 13 terawatts of energy globally, the sun continually provides us with 800 terawatts. Using organic photovoltaics to generate electricity from natural light in a cheap manner has the potential to decrease global strife, while fulfilling society's ever increasing need for energy. To date, several efforts have been made to design and synthesize new photoactive materials in order to optimize the performance of organic solar cells. Herein, we propose the synthesis of an end-cap unit, based on a fullerene derivative, to be incorporated in a block co-polymer. We expect a significant modification in the active layer morphology due to the presence of the acceptor component directly linked to semiconducting polymer. Modification of the active layer structure influences the distribution of the donor and acceptor components, and thus how well electrons propagate through the system. Finally, we are partnering with our materials laboratory to test the performance of our proposed polymer in organic solar cells devices.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Christian Perez

Major: Chemical Engineering

Mentor(s): Stephanie Mendes

Faculty Sponsor(s): David Valentine

Faculty Sponsor's Department(s):
Earth Science

Project Title: POTENTIAL FOR MICROBIAL CONSUMPTION OF MARINE HYDROCARBONS

Project Description:
Coal Oil Point, an active marine seep field in the Santa Barbara Basin releases methane, ethane, propane, and butane into the water column. These gases dissolve into the water column to form underwater plumes that fuel microbial consumption. Using real time tracking techniques of the dissolved hydrocarbon plume, samples were collected for microbial consumption rates. These rate measurements track microbial metabolism using isotopically labeled hydrocarbon. Microbes oxidize hydrocarbons to CO_2 and water, thus the isotopically labeled tracer can be tracked by measuring the products. Quantifying these products allows us to calculate an oxidation rate by measuring the amount of product produced per time. By determining the oxidation rate throughout the Coal Oil Point plume, estimates of these greenhouse hydrocarbons released to the atmosphere will be determined.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Jocelyn Ramirez

Major: Electrical Engineering

Faculty Sponsor(s): Chandra Krintz

Faculty Sponsor's Department(s):
Computer Science

Project Title: OPEN SOURCE PRIVATE CLOUD FILE-SYSTEM

Project Description:
Technology's availability and convenience has led to people employing multiple devices to satisfy their needs, with this arises the problem of how to make data portable. If someone created a presentation at their workplace but wanted to review it on their smart phone or desktop at home, how can this process be simplified? A way to tackle this problem is to utilize cloud computing, which allows data to be stored, shared, and interpreted outside of a local server. Currently various applications allow data to be uploaded and retrieved via the Internet, however most have a cap on the memory reserved or are run by developers who could use the uploaded data for their own gain. The research we are conducting focuses on creating an open source and private application that allows users to store and retrieve data through a cloud, avoiding external hardware and small memory limits. By utilizing different programming languages, such as Python, Java, and HyperText Markup Language (HTML), we can create a system that allows for data mobility via the Internet or a virtual folder. This application will be developed on two clouds, Google App Engine (Public) and App Scale (private). The main framework of the code was written in Python and the webpage in HTML and Java. By allowing hybrid cloud usage and making it open source, the issue of privacy is resolved. In the future we hope to create a virtual folder that is linked to the users account and can be installed onto any device. Application development is evolving towards cloud computing and our research explores this emerging technology while allowing users to access its power.

MATERIALS RESEARCH LABORATORY AT UCSB: AN NSF MRSEC

Rachel Scarlett

Major: Hydrology

Mentor(s): Stephanie Mendes

Faculty Sponsor(s): David Valentine

Faculty Sponsor's Department(s):
Earth Science

Project Title:
STABLE ISOTOPE RATIO OF 13C/12C AS INDICATORS OF MICROBIAL CONSUMPTION OF HYDROCARBONS FROM NATURAL MARINE SEEPS

Project Description:
Greenhouse gases, which warm the Earth's atmosphere, specifically methane, ethane, propane, and butane, are emitted from natural marine hydrocarbon seeps around the world. These greenhouse gases do not receive as much attention as carbon dioxide, but they are up to 26 times more detrimental than carbon dioxide as a greenhouse gas, and their effect on the marine environment is uncertain. Coal Oil Point, CA, the largest known marine seep field, releases more than 100 billion kg of gas each year. Gas released from this seep dissolves into the water column, giving microbes an opportunity to oxidize these natural gases before they are released into the atmosphere. In this study, we investigate the effects of microbial consumption on the ratio of carbon-13 to carbon-12 in the dissolved hydrocarbon plume in order to explore how microbial metabolism controls this ratio. Assuming that the lighter isotope is metabolized at a faster rate, the relative change of these isotope values can provide insight into the microbial activity around hydrocarbon seeps, and an advanced understanding of the down plume flow of the dissolved gases.