2015 UTEP Interdisciplinary Research (IDR) Symposium: Strategies for Enabling Interdisciplinary Research

Poster Abstracts

* = Graduate Student Poster

*1. Incorporation of Planetary Boundary Layer Height Modeling with GIS Techniques to Determine Criteria for Aerosolization and Transport of Infectious Agents in Southwestern United States

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The preliminary focus of this investigation is to conduct an agent-based modeling approach to particulate entrainment on a suite of pathogens endemic to the southwest region of the United States, negatively affecting agricultural and public health. An application of numerical modeling techniques will be employed to ascertain the conditions ideal for aerial transport of infectious agents due to interactions between the lower atmosphere and soils patterns associated with different vegetation types. Key to this process are atmospheric conditions in the lower troposphere, a regime known as the planetary boundary layer (PBL), where sufficient flux of energy (thermal and mechanical) aide in aerosolization and transport of infectious agents. PBL height varies due to diurnal and weather variations, which affect how bio-aerosols migrate within this layer. Preliminary results of this investigation will model pathogen release as a function of PBL height and vegetation type. The model will be spatially-explicit and account for a variety of other environmental factors such as slope and aspect. Once the model is generated, it can be applied to historical conditions and validated through comparison with data on infectious disease prevalence from nearby medical facilities. After validation, the model will be used to forecast future disease prevalence under different scenarios of climate and landscape change. The main points gathered from this interdisciplinary experience were the networks established and expertise gained in the fields of agricultural, atmospheric, and biological sciences. The interaction with experts in their fields allowed for a synergistic exchange of ideas that would otherwise be absent had the focus been uni-disciplinary. Additionally, this work provides a more comprehensive contribution to the growing field of geo-epidemiology; with positive impacts in public health. Highlights of those experiences will be presented as well.

*2. Multiplexed Instrument-Free Bacterial Meningitis Diagnosis on a PDMS/Paper Hybrid Microfluidic Biochip

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Bacterial meningitis remains the most serious form of meningitis disease. *Neisseria meningitidis* (*N. meningitidis*), *Streptococcus pneumoniae* (*S. pneumoniae*), and *Haemophilus influenzae type B* (Hib) are three most common pathogens accounting for most of bacterial meningitis. Due to the high fatality rate and the damaging effect caused by the untreated meningitis, immediate and early diagnosis of bacterial meningitis is in urgent need. Herein, we have developed a PDMS/paper hybrid microfluidic biochip integrated with loop mediated isothermal amplification (LAMP) for sensitive multiplexed bacterial meningitis diagnosis. The limit of detection of *N. meningitidis*, *S. pneumoniae* and *Hib* were a few copies

per LAMP zone within 1 hour. In addition, by using artificial cerebrospinal fluid (ACSF) samples, our instrument-free direct detection of pathogenic microorganisms was proved effective without laborious sample preparation process or the use of centrifuges. This hybrid microfluidic biochip with the introduction of paper for LAMP reaction enabled stable testing results over a much longer period than that of a paper-free microfluidic system. This work provides a low-cost, fast, and highly sensitive microfluidic approach for multiplexed instrument-free bacterial meningitis diagnosis, which has great potential for point of care (POC) detection of meningitis in resource-limited settings. This is an interdisciplinary research (IDR) project interfacing bioanalysis, bioengineering and clinical microbiology. The IDR with optimal resource allocation enables the team's successful collaborative work from different disciplines. The challenge is how to break the barrier among different disciplines toward integration.

*3. Earth, Life, and Semantic Web: Enabling the Integration of Environmental Data with Biodiversity Models

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Biodiversity models are important to understand environmental factors leading to the proliferation or decimation of different species. Generating useful biodiversity models requires scientific expertise from a number of different disciplines, including: environmental science, geographic information systems, statistical modeling, computer science, and biology. Different scientific disciplines (and different scientists within disciplines) have various perspectives on data and models, sometimes referred to as "scientific lenses". ELSEWeb's semantic-based approach relies on the creation of a common, shared vocabulary (*i.e.* ontologies) that describes information across disciplines to support a common goal: *the automatic generation of biodiversity models under scenarios of climate change.* The current implementation of ELSEWeb successfully integrates and manipulates more than 6000 datasets provided by the Earth Data Analysis Center (EDAC) from the University of New Mexico with a sample of 1000 species distributions, and 11 algorithms for the generation of biodiversity models at the Lifemapper Species Distribution Modeling Center from the University of Kansas. The greatest challenge of this approach was the aligning of different expectations, technical skills, scientific lenses and vocabulary from the team members. Harvesting additional data of interest is still an important part of the ongoing development. The best practices observed in this collaboration, including the use of common vocabularies and face-to-face interactions will be highlighted in this presentation.

4. Investigations of boron-doped diamond films - a confocal Raman mapping, infrared absorption, and SEM study

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Building on the well studied properties of diamond such as hardness, chemical inertness, and low electron emission threshold voltage, the current study is directed towards improving critical properties of electrode coating materials for clinical studies of deep brain stimulation using fast scan cyclic voltammetry (FSCV). To demonstrate the capabilities of confocal Raman mapping in providing detailed and accurate analysis of the degree of complexity of a series of boron-doped polycrystalline diamond films grown by chemical vapor deposition, in this study we combine such results with information provided by more conventional techniques of scanning electron microscopy (SEM) and infrared (IR) absorption spectroscopy. To provide the necessary conductivity for the application, samples were

synthesized using various partial pressures of trimethylborane, methane, and hydrogen gases at substrate temperatures of about 800 ^{0}C. SEM images, which show uniform distribution of film crystallites, have the limitation of being unable to differentiate the exact distribution of boron in the diamond. As infrared spectroscopy, confocal Raman mapping not only provides information about material composition at the molecular level, but also images the local distribution of pure diamond and boron-doped diamond. This work, which is based on a collaborative research agreement between the University of Texas at El Paso and the Mayo Clinic in Rochester, Minnesota, demonstrates the effectiveness of Raman and IR absorption spectroscopies for observing small structural modifications in the morphology of boron-doped diamond thin films, and for providing information that is complementary to that obtained by other means of optical and electron microscopy. The high quality results enabled by this interdisciplinary research were published in a peer-reviewed article.

5. A Drude model analysis of resistivity and free carriers in boron-doped diamond films

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Diamond related materials such as boron-doped diamond have seen a substantial increase in interest for use as electrode coating materials for clinical studies of deep brain stimulation. In this study we present an alternative, more accurate method for determining important characteristics, including time constant, carrier concentration, and resistivity, of such thin film materials by using the signature of their Drude-like metallic behavior in the far-infrared (IR) spectral range. The transmittance of a thin film in the infrared is related to its electrical conductivity, which in turn is a function of the frequency of the applied IR field. Since the characteristic frequency (the inverse of the average time between two carrier-core collisions) is typically in the infrared range, IR transmission measurements are particularly suited to determining the abovementioned material characteristics. Unlike the direct determination of conductivity from the four-point probe method, using far IR transmittance provides additional information about the material, namely, whether the incorporation of boron resulted in a large concentration of acceptors (hence, a concentration of carriers) or in inducing defects in the diamond lattice (hence, a decrease in the time constant). Boron-doped diamond samples produced using chemical vapor deposition and analyzed in this work show a resistivity range between 0.2 and 0.05 Ω cm. Different sample growth conditions show that an increase in boron concentration resulted either in an increase in the carrier concentration, leading to a decrease in the resistivity, or in a decrease in the time constant, hence, an increase in resistivity. Fine tuning of growth conditions allow us to optimize these two parameters to obtain samples of optimal low resistivity. The results of these interdisciplinary collaborative research efforts between the University of Texas at El Paso and the Mayo Clinic in Rochester, Minnesota, had been published in a peer-reviewed article.

*6. Microscopic, spectroscopic, and internal stress analysis in close-space sublimation grown cadmium telluride

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Cadmium telluride (CdTe) remains one of the materials of interest in the fabrication of photovoltaic cells and infrared devices, mainly because of its suitable crystal structure as well as of its small, direct bandgap of 1.5 eV. Since development of such devices requires a high quality and low defect material,

the goal of this study is to microscopically and spectroscopically examine not only crystallinity, but also the induced stress in the material due to the effect of substrate orientation. This information is valuable if optimization of sample growth conditions is envisioned. Prior to CdTe deposition by close-spaced sublimation (CSS), Si (111) and (211) substrates were patterned using photolithography and dry etching to create 500 nm to 1 μm pillars. Scanning electron microscopy (SEM) images besides demonstrating uniform, selective growth of polycrystalline CdTe, reveal fewer defects and less twin-microcrystallite formation if Si (211) is used. Crystallinity of the samples was investigated by Fourier transform infrared absorption and Raman spectroscopies. The far-infrared transmission data show the presence of transverse optical (TO) and surface optical (SO) modes, the latter being direct evidence of confinement in such a material. Qualitative identification of the induced stress in the samples was achieved by performing confocal Raman mapping microscopy on their surfaces. As high quality materials with excellent ordered structure are needed for developing photovoltaic devices, the results of this research demonstrate the importance of detailed, comprehensive analysis in optimizing and improving CdTe characteristics. The results of these interdisciplinary collaborative research efforts between the Department of Physics and the Department of Electrical and Computer Engineering at the University of Texas at El Paso have been submitted for publication in a peer-reviewed article.

7. Estimating multi-scalar ecosystem impacts of freshwater withdrawals: A case study of the Kalamazoo watershed

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Like most natural ecosystems that are open and capable of undergoing self regulation, watersheds are complex and need to be broken down into simplified systems to better understand them. This study interprets a Great Lakes Basin watershed as a hierarchy of spatial scales and applies a GIS-based water withdrawal ecosystem impact methodology and economic water uses to estimate the environmental impacts of freshwater withdrawals. Environmental impacts are shown to vary with the spatial scale of the analysis, and therefore the optimal water withdrawal level at which environmental, economic and social values are optimized also varies with the spatial and temporal scale of analysis. This analysis is important because it explains the relationship between spatio-temporal scale and water use for economic activities in a watershed. The results can help inform integrated water resources management approaches, in addition to providing a better understanding of scale-impact relations and challenges associated with sharing water among competing uses in an environment where water scarcity is being exacerbated by climate change. This interdisciplinary research integrated contributions from the disciplines of geography, economics and engineering and social sciences. The following lessons learned from this project can be highlighted: (i) Integration of different disciplines into one coherent project is a gradual process that requires some deliberate steps in the early project phases. We achieved this through a couple of early stakeholder workshops to help consolidate collaboration. (ii) Visionary leadership is required to keep researchers from diverse fields with different expected project outcomes focused on a common project goal. We utilized an external project advisory board to great effect to provide overall focused guidance. (iii) It is crucial to maintain active management of various project responsibilities to achieve interdisciplinary integration. We utilized bi-weekly teleconferences effectively throughout the project life to overcome the physical separation of project researchers.
Keywords: ecosystem, scale, GIS, impact analysis, freshwater

8. A Narrative Analysis Approach to Understand Latinas' Resilience and Persistence in Computer Science and Engineering

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Most professions have reached gender equity with the exception of computer science and engineering. Female enrollment numbers are far from parity (under 19%, with Latinas representing 9% of all females) in computer science and engineering (CS/Eng). To understand the mitigating factors influencing Latinas' enrollment and persistence in CS/Eng, an interdisciplinary team of scholars at UTEP has undertaken a three-year NSF-funded research project to understand those factors. The overarching question is: What is the relationship among identity, resilience, and persistence of Latinas in computer science and engineering? The study was framed using a socio-cultural theory of identity (Gee, 1995/2005; 2001; Holland, Lachicotte, Skinner, and Cain,1998). Identity is constructed through action and in interaction with a particular social group—one joined willingly joined and granted access into. Twenty-six (26) participants were selected using purposeful sampling (Merriam, 2001). They were interviewed using an ethnographic interviewing method (Seidman, 2006). Data is being analyzed using narrative analysis, constant comparative analysis, and life charting. Our findings suggest that peer groups play a key role in Latinas' engineering identity development, with participants linking this identity to academic success. Furthermore, through narrative analysis we identified ways affinity groups enable persistence in CS/Eng. Ten participants volunteered "narratives of uncertainty," stories in which they doubted whether engineering was the correct choice for them. In them, participants presented crises points immediately followed by ways in which affinity groups were instrumental in resolving the crises and thus continuing on an engineering pathway. Said one participant: "If it weren't for those friends […] I don't think I would have done as well." As an interdisciplinary team, we learned about the value of analysis of qualitative data from different perspectives, and the importance of respecting disciplinary perspectives; also, assumptions of researchers' roles should be clarified at the outset of the project.

9. Interdisciplinary and International Smart City Research Innovation Program

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Making cities "smarter" or transforming them into smart cities is the process of improving economic competitiveness and quality of life by implementing cyberinfrastructure technologies throughout a city. UTEP researchers have been active in various aspects of research that has the potential to "smartifying" cities. Their efforts need to be integrated and strengthened in order to compete for extramural research funding at the national and international levels. Nine researchers from Civil Engineering, Electrical & Computer Engineering, Computer Science and Industrial, Manufacturing & Systems Engineering departments in the College of Engineering have formed a team with partners in Department of Information Systems at Universidad de Guadalajara, Mexico, and Faculty of Transportation Sciences at Czech Technical University, Czech Republic. The propose of this IDR project to review the start-of-the-art research in smart city initiatives across the world, identifying research gaps and issues, and develop an integrated, multidisciplinary research agenda for an international smart city research program. The major activity of this IDR project is a tri-national smart city workshop to be held in Guadalajara, Mexico in August 16-22, 2015.

*10. Gelatin Nanoparticle Encapsulation and Delivery of Anti-Parasitic Compounds for Treatment of Chagas Disease

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Chagas disease is caused by the flagellate protozoan Trypanosoma cruzi which is transmitted to mammals through blood-sucking reduviid bugs. Present anti-trypanosomal therapy is highly toxic leading to an urgent need for new compounds and delivery systems. Using Biology, Chemistry, and Biomedical Engineering interdisciplinary studies, we have developed novel compounds that could have efficient anti-trypanosomal activity. However these compounds, synthesis of novel Mannich bases, lack in solubility making them difficult for delivery. Using biomedical engineering tools, the novel bases were encapsulated within gelatin nanoparticles allowing for a controlled release of the compounds. The cytotoxicity in mammalian cells and effect on the parasite of this release can be measured using biological tools providing an insight to the therapeutic effectiveness. To properly profile the Mannich base loading process, integral nanoparticle properties were identified. Several factors were been found to effect nanoparticle size and yield including pH and desolvating agents. The long-term goal of this project is to profile and optimize Mannich base encapsulation and release to increase effectiveness in delivery. It is hypothesized that optimized conditions for compound loading and delivery, using nanoparticles, will be more effective in delivering anti-parasitic treatment compared to current protocols. The primary specific aim is to synthesize hydro gelatin nanoparticles as carriers for the anti-parasitic compounds in order to measure loading and release efficiency using absorption wavelengths of each corresponding base. Our data demonstrates base encapsulation at low pH levels and release at physiological pH; in addition compound concentration was found to vary depending on different factors such as the rates at which the desolvating agent and cross linker are added. These results allow us to confidently speculate that this nanoparticle encapsulation will have an effect on the parasite while maintaining low cytotoxicity in mammalian cells, promoting a novel effective delivery treatment of Chagas Disease.

*11. An innovative training approach to decrease joint contact loads during plyometric exercises

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High intensity lower-body plyometric exercise was predicted the most popular fitness training modality for 2014. With intense loading conditions and quick repetitive movements that typically occur during plyometric exercises, the risk of joint injury increases, which may in turn lead to early joint degeneration such as osteoarthritis. An interdisciplinary approach allow us to address such clinical issues from different perspectives. Both health sciences and engineering focus on reducing joint injury and increasing quality of care for public. Through health sciences, we can look at the impact of training modalities and through engineering we can look at quantifying the impact of the training. Current implementation of this research shows that auditory feedback has the potential to train technique over two degrees of freedom. The training group was able to achieve target flexion angles within 3° and their center of pressure target. The next phase of this research will be training more subjects and quantifying the effects of center of pressure *in vitro*. A beneficial challenge of this research has been looking at the same clinical issue from different perspectives. The team has gained a deeper understanding of what is practically important when training as well as, what needs to be quantified for deeper understanding of joint injury. Working as an interdisciplinary team develops communication, leadership, and analytical skills while promoting a relevant research topic with a greater public impact. This work will pave the

way for futures studies that will lead to generation of personalized performance assessment training programs that lower the risk of joint injury when performing highly dynamic tasks.

*12. Synthesis of an amino-acid building block for the solid-phase peptide synthesis of photoreactive collagen-mimicking peptides

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Cells can be easily grown in vitro on two-dimensional surfaces made from biocompatible materials. In tissue engineering collagen-derived materials have been used for the generation of gels on which cell proliferation can occur. It is much more difficult to grow cells into three-dimensional forms due to the lack of a vascular system that is important for the delivery of oxygen, nutrients, and growth factors. Our goal is to generate a novel type of collagen gel with microtunnels on which endothelial cells can grow into vascular structures, which requires the convergence of expertise from three different disciplines, i.e. chemistry, physics, and bioengineering. Collagen is a structural protein rich in glycine (Gly), proline (Pro) and hydroxyproline (Hyp) that is common in connective tissue. Collagen-mimicking peptides typically consist of repeating sequences of Pro-Hyp-Gly. Here we present a seven-step synthesis of a photoreactive glycine building block from 5-carboxylic acid indole for the solid phase peptide synthesis of collagen-mimicking peptides. N-acylated nitroindolines are stable to mild reaction conditions and ambient light, but they undergo photolysis when illuminated with light of 350 nm. Our data supports that N-acetyl-nitroindoline may undergo cleavage by a two-photon absorption mechanism when irradiated with 700 nm from a femto second laser. In the near future, the photoreactive nitroindoline-containing glycine will be incorporated into peptides (Michael group) for the preparation of collagen-like gels (Boland group), which can then be manipulated with 700 nm laser light generating microtunnels (Li group) for cell growth inside of the gel (Boland group). The biggest challenge faced in this interdisciplinary project is that the advancement of the project is partially dependent on the sequential results each group obtains, although some aspects of the project can be explored independently by each group. For example, while one group synthesizes peptides, another explores the two-photon chemistry on a model compound.

*13. Phenomenological Ethics: An Interdisciplinary Dialogue of Ethics

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I am interested in connecting with faculty and graduate students who are involved in raising the question, “What is ethics?” This project envisions an open dialogue across disciplines in order to form a solid foundation for ethics. In recent years, the field of ethics, as a non-philosophical discipline, has experienced an incredible growth. For instance, the development of bio-ethics, business ethics, ethics in criminal justice and ethics in engineering, among many others, provide evidence of the importance of ethics in society. There are two forms of ethics that are prominent: an institutional code of ethics and an individual code of ethics. Often times, these two codes are not congruent with one another. As a graduate student, my interest rests on the possibility of bridging together, what might seem, two different forms of how to live an ethical life. This project will take the bottom-up methodology. That is, it begins with the subjective experiences of individuals. In doing so, the philosophic prose of Emmanuel Levinas will shape this work. This project gains its momentum from Dr. Simon’s investigation of phenomenological ethics.