2018 STEM Research Symposium

Hosted by the Center for Biomedical Engineering & Science

Acknowledgements

Welcome to the 3rd Annual STEM Research Symposium!

The primary focus of this event is to give graduate students within the STEM fields a platform to present their research findings to the UNM community and the general public. As such, we thank you for being here today. This is a free, annual, student led, collaborative effort between UNM's student groups and as such we would like to take this time to thank both those who have funded this event through donations and those who have taken precious time to make sure this event was possible.

We thank the following groups/businesses for financial support for today's activities:

Chemical, Biological, and Biomedical Engineering GSA

Nanoscience and Microsystems Engineering Program	Chemistry and Chemical Biology Department	Chemical and Biological Engineering Department

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Special Thanks to the event committee members who spent countless hours working on this event:

UNM Outreach Team:	Adam Quintana, Adan Myers y Gutierrez, and Annette Fernandez
Fundraising Team:	Emma Garcia, Jane Romero-Kotovsky, Joseph Alden, and Tracy Mallette
Guest Speaker Team:	Christian Denny, and Courtney Pruitt
Student Associations:	AIChE, BSGP, CGSA, IEEE, NSBE, NSME GSA and SWE

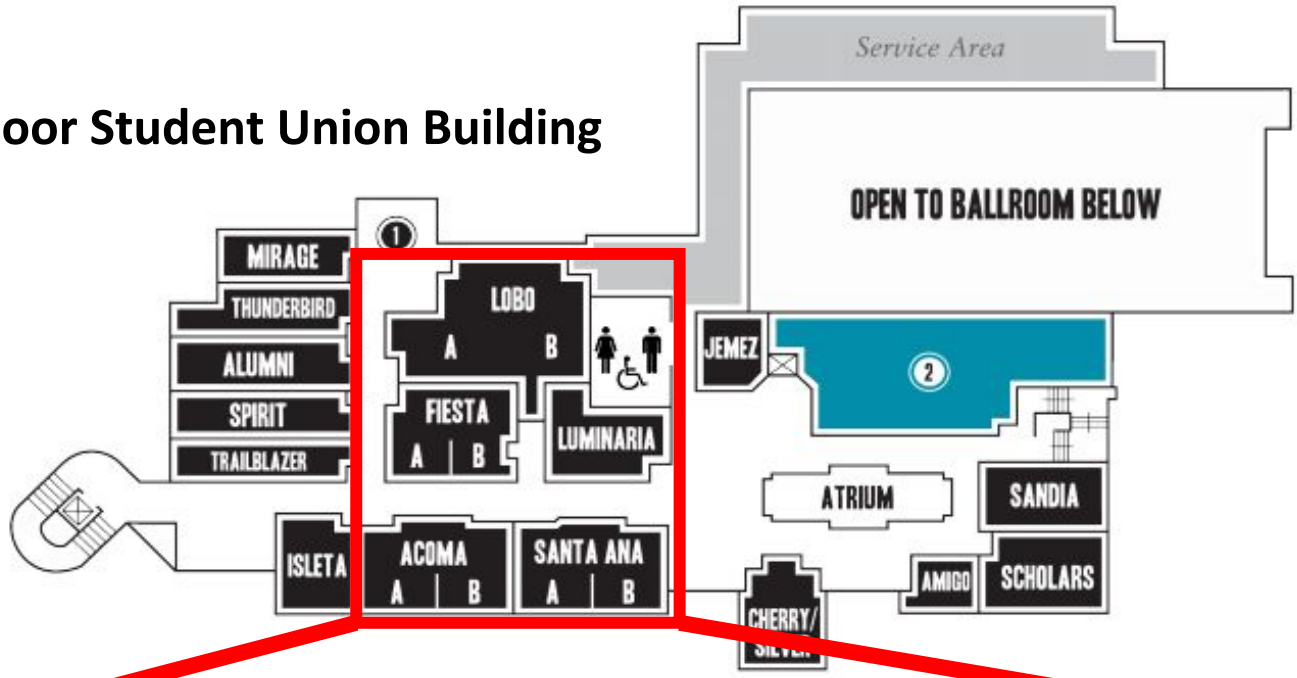
Agenda

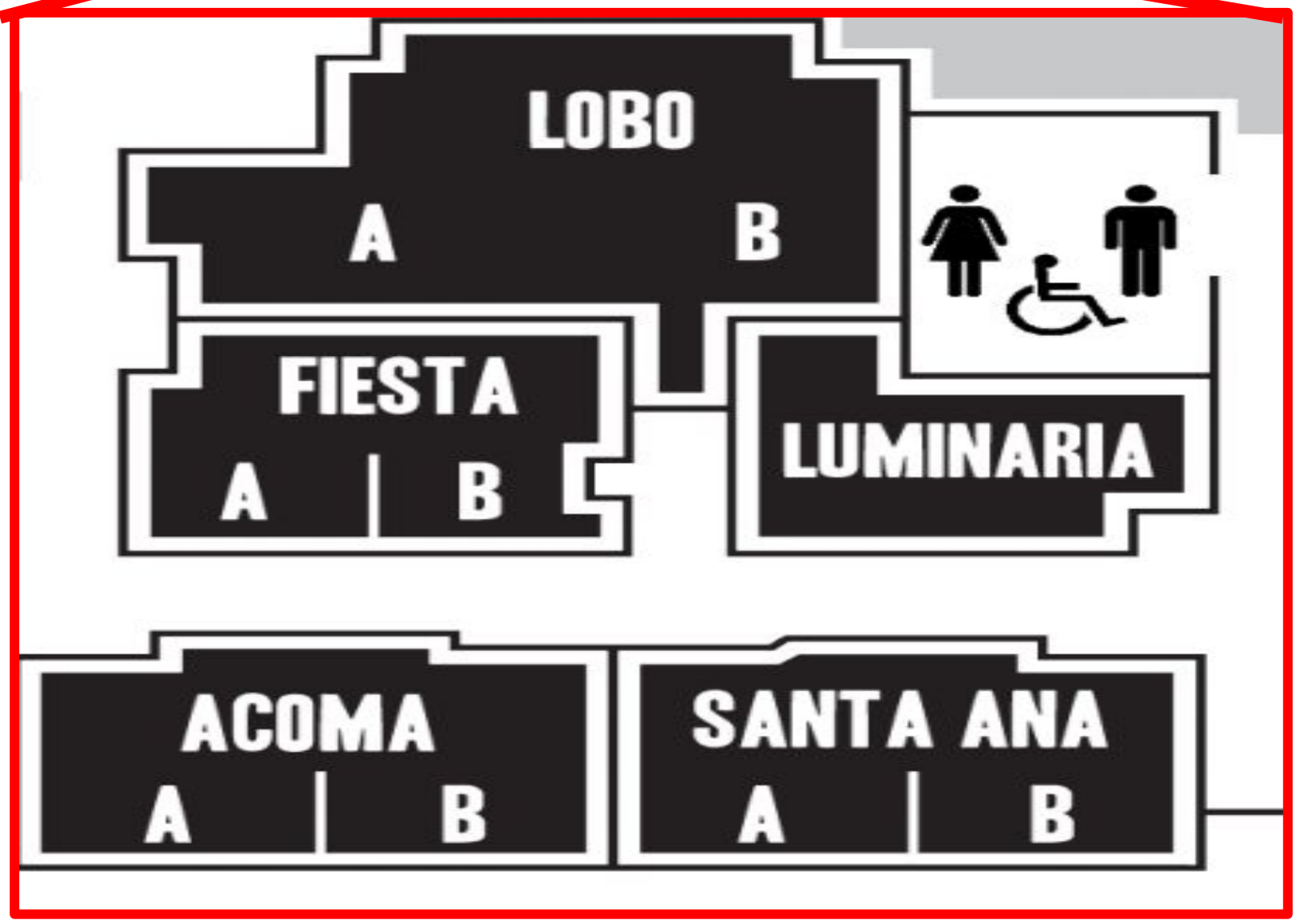
All Sessions Located on the 3rd floor of the Student Union Building

8:30am-9:45am Santa Ana A&B	Breakfast
9:15am-10:15am Acoma A&B, Fiesta A&B	Poster Session A
10:25am-11:05am Santa Ana A&B	"Lossless Dielectric Spacer Layer and Ultrasharp Plasmon Resonance" Presented by Bijesh Kafle, PhD Chemistry and Chemical Biology "Design and Characterization of a Pinhole Mask System for Direct Spatial Imaging of Low-Energy Gamma-Radiation Sources" Presented by Phoenix Baldez, PhD in Nuclear Engineering
11:15am-11:55am Santa Ana A&B	"Comparison of Linear and Nonlinear Dynamics of a Virtual Telescope" Presented by Richard Adcock, PhD in Mechanical Engineering "Model for Precision Application Slot-Die Coating and Investigating the Mechanics of the Low-Flow Limit" Presented by Robert Malakhov, PhD in Nanoscience and Microsystems Engineering
12:10pm-1:10pm Lobo A&B	Lunch "Education and Research at the School of Engineering, Innovation and Economic Development" Presented by our Guest Speaker: Dean Christos Christodoulou from UNM
1:20pm-2:20pm Acoma A&B, Fiesta A&B	Poster Session B
2:30pm-3:10pm Santa Ana A&B	"Solvation and Surface-component interactions effect on double layer structure and properties: Explicit Solvent Model and Surface Charge regulation" Presented by Raviteja Vangara, PhD in Chemical Engineering "Targeting the vulnerable phase of spreading depolarization with ketamine does not prevent plasticity mechanisms" Presented by Kate Reinhart, PhD in Biomedical Sciences
3:20pm-3:50pm Santa Ana A&B	"Optically Active Nanostructures and its Applications in Energy Conversion " Presented by our Guest Speaker: Dr. Sanchari Chowdhury from New Mexico Technology Institute of Mining and Technology
4:00pm-4:40pm Santa Ana A&B	"Diffuse carbon dioxide flux measurements as evidence for hot dry rock geothermal system viability" Presented by Kristen Rahilly, PhD in Earth and Planetary Sciences "Developing a pH responsive hydrogel for colonoscopy preparation" Presented by Phuong Anh Nguyen, PhD Biomedical Engineering
4:45pm-6:00pm Lobo A&B	Dinner followed by Awards

Map

3rd Floor Student Union Building





Poster Session A

9:15am-10:15am | Acoma A&B, Fiesta A&B

Poster Number	Department	Title	Keywords	Authors
1	Biochemistry	Medicinal Plant Extraction and Analysis	Kirby-Bauer Assay, Antimicrobial Properties, Steam Distillation, Essential Oils, Chamisa, Chaste tree	**Shania Sanchez**, Victor French, Tracy J. Terry
2	Biology	Encapsulation of Poly(Ethylene Glycol) in a Smart Hydrogel for Colonoscopy Preparation	Polymer, Smart Hydrogel, Drug Delivery, Colonoscopy, Gastroenterology, Encapsulation	**Darnell Cuylear**, Phuong A.H. Nguyen, Heather Canavan
3	Biomedical Sciences	TNF-α priming regulates CD82 expression and Bone Marrow Homing of Hematopoietic Stem and Progenitor cells	Hematopoietic Stem Cells, Bone Marrow Homing	**Erica M. Pascetti**, Christina M. Termini, Muskan Floren, Jennifer M. Gillette
4		Altered expression of angiogenesis-associated miR-150-5p and its target Vezf1 in mouse models of prenatal alcohol exposure	Prenatal Alcohol Exposure, Neuroscience, MicroRNA	**Gabriela Perales**, Amy S. Gardiner, Kevin K. Caldwell, Andrea M. Allan, Nora I. Perrone-Bizzozero
5		Default patterning produces pan-cortical glutamatergic and CGE/LGE-like GABAergic neurons from human pluripotent stem cells	Human Pluripotent Stem Cells, Neuronal Differentiation, Interneurons, CGE	**Crina Floruta**, Ruofei Du, Huining Kang, Jason Stein, Jason P Weick
6		The effect of germline polymorphisms on somatic hotspot mutations in TP53 for the treatment of High Grade Serous Ovarian Carcinoma	TP53, Tumor Suppressor, Somatic Mutations, Germline Polymorphisms, Ovarian Cancer	**Cristabelle De Souza**, Jill Madden, Jeremy Chien
7	Chemical Engineering	Gel encapsulation of Mel28 cells using DEX/E3 water-water system	Biotechnology, Microfluidics, Biological Engineering	**Mariah Gallegos**, Andrew Shreve, Nick Carroll, Frank Fencl, Aidira Dora Yajaira Macias Gonzalez
8	Chemistry	Photochromic Polypyridyl Ruthenium Sulfoxide in Photofunctional Materials	Photochromism Photorefraction Holography	**Maksim Livshits*** Jeffrey Rack

Poster Number	Department	Title	Keywords	Authors
9	Electrical and Computer Engineering	Modeling Cascading-Failures in Power Grids Including Communication and Human Operator Impacts	Cascading-failures, Interdependent Systems, Markov chain	**Rezoan A. Shuvro**, Zhuoyao Wang, Pankaz Das, Mahshid R. Naeini, Majeed M. Hayat
10		Resolution Enhancement For Optical Microscopy	Microscopy, Resolution Limit	**Preyom Dey**, Alexander Neumann, S.R.J. Brueck
11	Mechanical Engineering	Radial Head Instability and Limited Hand Rotation after IOM Injury	Biomechanics, Upper Extremity, Injury	**Jodie Gomez**, Tom Pollard, Drew Newhoff, Erica Gauger, Jorge Orbay, Deana Mercer, Christina Salas
12		Effect of Cr Content on the Phase Stability of Ferritic/Martensitic Steels under Neutron Irradiations at FFTF	Phase Stability, Ferritic Martensitic Steels, Neutron Irradiation	**Md M. Hassan**, M.B. Toloczko, S. A. Maloy, O. Anderoglu
13	Nanoscience and Microsystems Engineering	Resolving inter-chromophoric coupling in tetrakis(perylene diimide) complexes	Physical Chemistry, Photophysics, Organic Solar Cells, Spectroscopy, Single Molecule Analysis	**David J. Walwark Jr**, Qinghe Wu*, Luping Yu*, John K. Grey
14		Charge-transfer plasmons in particle-substrate metallic systems	Charge-transfer, Nanoparticle, Metallic Substrate, Plasmons, Gold	**Paul Gieri**, Bijesh Kafle, Hamed Kookhaee, Tefera Entlele, Sharmin Haq, Alejandro Manjavacas, and Terefe Habteyes
15	Nuclear Engineering	Effect of processing techniques on electrical, thermal, and mechanical properties of 14YWT	Nanostructured Ferritic Alloys (NFAs), Processing Techniques, Electrical Resistivity, Thermal Conductivity	**Deep R. Patel**, U. Carvajal-Nunez, A. Nelson, S. A, Maloy, O Anderoglu
16		Formation of γ'' Precipitates in Alloy 718 Under Irradiation Environments		**James Pike**, Osman Anderoglu
17	Physics	Surface plasmon polariton beams with flat top profiles	Plasmonics, Surface Plasmons, Metal Optics	**Lauren Zundel**, Rosario Martinez-Herrero, and Alejandro Manjavacas

Oral Talk Session A

10:25am-11:05am | Santa Ana A&B

10:25am-10:45am Presentation by Bijesh Kafle

Lossless Dielectric Spacer Layer and Ultrasharp Plasmon Resonance

Bijesh Kafle, and Terefe G. Habteyes*
Department of Chemistry and Chemical Biology, and Center for High Technology Materials

Plasmonic nanocavity between metal nanoparticles and flat metal film enhances the huge optical field and has tremendous technological applications. Fabricating stable nanocavity requires robust and inert dielectric materials as spacer layer separating the nanoparticles and metal film. Here we use monolayer of quantum dots film as dielectric spacer layer to form the nanocavity between gold nanorods and gold film. Using single particle dark field scattering, we observed remarkable line width narrowing for gold nanorods on nanocavity and also increase of its scattering intensity as compared to gold nanorods on silica substrate. The similar spectral properties are observed for different size of gold nanorods at different resonance energy. This dramatic resonance narrowing can be due to hybridization between the plasmonic nanocavity and gold nanorods. Here, we report the robust and inert material as dielectric spacer layer for efficient light coupling and local field enhancements.

10:45am-11:05am Presentation by Phoenix Baldez

Design and Characterization of a Pinhole Mask System for Direct Spatial Imaging of Low-Energy Gamma-Radiation Sources

Phoenix Baldez, Paul DeRego, Adam Hecht
Department of Nuclear Engineering

This work describes the development of radiation detection systems to identify and image special nuclear material (SNM) using low-energy gamma rays. Using a spectroscopy system, the radioactive sources can be identified while images can be produced concurrently. Low-energy gamma rays are notoriously hard to detect and image due to ease of shielding, so varying imaging techniques were applied to different situations. A pixelated, solid-sate CdZnTe gamma ray detector was used, and lead masks were applied to vary the detector response and produce image projections on the detector plane. Single pinhole masks, optimized for the pixelated detector geometry, gave a high-resolution image, though poor geometric efficiency. Using a multiple pinhole mask creates several sub-images per detection window, which were used to synthesize detailed reconstructions of the original source, with increased resolution over the individual sub-images. The multiple pinhole mask design had two benefits over the single pinhole mask. First, the multiple pinhole mask design greatly increased the geometric efficiency and thus the total intensity on the detector. Secondly, information contained in the full array of sub-images was also used to extract depth of field information about the radiation sources so increased locational accuracy was achieved.

Oral Talk Session B

11:15am-11:55am | Santa Ana A&B

11:15am-11:35am Presentation by Richard Adcock

Comparison of Linear and Nonlinear Dynamics of a Virtual Telescope

Richard Adcock, Dr. Asal Naseri
Department of Mechanical Engineering

The Virtual Telescope for X-ray Observations, VTXO, is made up of two 6U-CubeSats which are to be flown in a precise formation flying configuration. Both spacecraft will be aligned at apogee in order to create very long focal lengths, thus creating a virtual telescope capable of creating images that normally take large single spacecraft to achieve. As the separation distances between spacecraft increase, the linear equations of motion begin to break down and neglect certain phenomena such as perturbations. Because of this, the use of nonlinear dynamics offers many advantages over their linear counterparts such as being able to account for disturbances and perturbations. Once the nonlinear equations of motion for each spacecraft in the formation have been formulated, it is possible to relate the follower spacecraft to the leader spacecraft. Then using state-space analysis, we can create the system of nonlinear equations that describes the orbit of the formation. With the linear and nonlinear dynamics formulated, a comparison between the two can be created allowing us to visualize and analyze the differences between the two techniques and to measure certain metrics such as error between the two methods. The use of nonlinear dynamics helps expand the field by giving a more accurate orbit and will allow for the creation of more precise controllers in order to optimize trajectories and fuel consumption.

11:35am-11:55am Presentation by Robert Malakhov

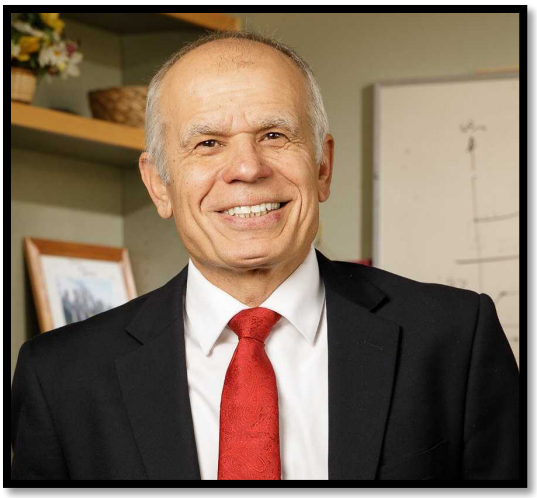
Model for Precision Application Slot-Die Coating and Investigating the Mechanics of the Low-Flow Limit

Robert Malakhov, Kristianto Tjiptowidjojo, Randall Schunk
Department of Nanoscience and Microsystems Engineering

Slot die coating is a precision pre-metered, film-deposition process compatible with a wide range of materials, including colloidal inks, low-molecular weight polymers and thermosets. Of topical interest to precision electronics applications is the deposition of high-cost nano-material dispersions (inks) over moderately sized (>10 cm^2) areas with sub-micron wet film thickness. In these applications the speed of deposition is less important than non-uniformities resulting from start-up and shut down transients. In this work, a two-dimensional model has been developed to understand the limits of the process and to predict the thinnest possible film achievable. Coined as the low-flow limit, this parametric operating boundary presents the minimum uniform, defect-free film achievable at a given set of liquid properties and die geometry. We investigate the low-flow limit with a model that minimizes assumptions on the bead configuration and compare it with published experimental data.

Guest Speaker

12:40pm-1:10pm | Lobo A&B



Dr. Christos Christodoulou

Jim and Ellen King Dean of Engineering and Computing
University of New Mexico

Education and Research at the School of Engineering, Innovation & Economic Development

Engineering, Computer Science and other STEM fields form the engine that powers our innovation ecosystem and economy. STEM research is not only essential to grow our economy but also provides security and well-being to our society by tackling challenging national problems such as energy, water, health, space, the environment, and national security. Employment in STEM occupations grew significantly faster than employment in non-STEM occupations over the last decade and STEM occupations are projected to grow even more. In this talk the following topics will be discussed:

- The skills the future workforce will need to be employable in 2030.
- How robots slowly and inevitably will perform most of the work currently done by human beings and whether the STEM fields immune to this disruptive force.
- The growth of engineering degrees in the US.
- Statistics on New Mexico High School Students' interest in STEM.
- Why the School of Engineering is in a great position to play a pre-eminent role in preparing a highly qualified engineering and computer science workforce required to attract more industry to New Mexico and truly become one of the main economic engines for the State of New Mexico and the rest of the country.

Christos G. Christodoulou received his Ph.D. degree in Electrical Engineering from North Carolina State University in 1985. In 1999, he joined the faculty of the Electrical and Computer Engineering Department of the University of New Mexico, where he served as the Chair of the Department from 1999 to 2005. He is one of the founders of COSMIAC (SOE research Center for Space Electronics) and served as a director of the center from 2012 to 2014 and as the Associate Dean for Research from 2014 to 2017.

He is an IEEE Fellow, a Distinguished Professor at UNM, and a member of the Alumni Hall of Fame for the ECE Department, at North Carolina State University.

Has published over 500 papers in journals and conferences, written 17 book chapters, co-authored 8 books, and has several patents. Over his acadenic career he has served as the major advisor for 31 Ph.D, 71 M.S. Students, 9 Post Doctoral Fellows, and received over $50M in funding as a PI and Co-PI from several federal agencies and industry. His research interests are in the areas of modeling of electromagnetic systems, machine learning in electromagnetics, high power microwave antennas, reconfigurable antennas for cognitive radio, and RF/Photonics.

Poster Session B

1:20pm-2:20pm | Acoma A&B, Fiesta A&B

Poster Number	Department	Title	Keywords	Authors
18	Molecular and Cellular Biology	Cell Type-Specific Response to Spindle Misorientation and Effects on Tissue Growth	Stem Cell, Mitosis, Tumor, Neuroblast	**Amalia S. Parra,** Christopher A. Johnston
19	Biology	Recent evolution of the *Mycobacterium tuberculosis* genome	Tuberculosis, Evolution, Phylogenomics, Horizontal Gene Transfer, Antibiotic Resistance	**Julie Allison Spencer**
20	Biomedical Engineering	Comparing Synthesis Methods of Oligo (poly (ethylene glycol) fumerate) for Heart Valve Tissue Engineering	Heart valve, Tissue Engineering, Biomaterial	**Quan M. Huynh**, Kent E. Coombs, Matthew N. Rush, Elizabeth L. Hedberg-Dirk
21	Biomedical Sciences	Enduring pathological effects of prenatal alcohol exposure on touch hypersensitivity following peripheral nerve damage via neuroimmune mechanisms	Neuropathic Pain, Prenatal Alcohol Exposure, FASD, Proinflammatory Cytokines, Allodynia	**Joshua J. Sanchez**, S. Noor, S. Davies, D. D. Savage, E. D. Milligan
22		Increasing Neural Activity in the Orbitofrontal Cortex Using Optogenetics After Prenatal Alcohol Exposure	Prenatal Alcohol Exposure, Optogenetics*, in vivo* Electrophsyiology, Interneurons	**Johnny A. Kenton**, K. Marquardt, J. L. Brigman
23	Chemistry	Design and Synthesis of a Zwitterionic Metal-Organic Framework for Selective Gas Adsorption	MOF, Zwitterionic, 4-fold Interpenetration, IAST Selectivity	**Sheela Thapa**, Diane A. Dickie, Eshani Hettiarachchi, Gayan Rubasinghege, Yang Qin
24		Ni-catalyzed 1,2 Dicarbofunctionalization of Unactivated Olefins and its Application to the Synthesis of Lignan Natural Products	Ni catalyst, Dicarbofunctionalization of Olefin, Liganan Natural Products	**Shekhar KC**, Prakash Basnet, Surendra Thapa, Bijay Shrestha, and Ramesh Giri*

Poster Number	Department	Title	Keywords	Authors
25	Civil Engineering	Machine Learning classifiers applied in event-based sensor: DVS128	Machine Learning, Event-based Sensor, Deformation, Neural Network	**Xiaomeng Li**, Fernando Moreu
26	Electrical and Computer Engineering	Measuring Liquid Properties on Nano-scale Photoresist 1D Patterned Structures	Directional wetting, Nano-scale, Patterned Structures, Cassie-Baxter and Wenzel Models, Contact angles	**Juan J. Faria Briceno**, S. R. J Brueck, Randy P. Schunk, Alexander Neumann
27		3D Bioprinting+Electrospinning Hybrid System for Functionally-Graded Scaffolds of the Bone-Ligament Interface	Tissue Engineering, 3D Bioprinting, Additive Manufacturing	**Christopher Buksa**, Steven Nery, Darielys Morales, Fermin Prieto, Ava Mauser, Chanju Fritch, Christina Salas
28	Mechanical Engineering	A Biomechanical Justification for Conservative Management of Partial Extensor Tendon Lacerations	Biomechanics, Extensor Tendon	**Jasmin Regalado**, Darielys Mejias-Morales, Benjamin Johnson, Jeremiah Johnson, Patrick Gilligan, Lauren Long, Deana Mercer, Christina Salas
29		Attitude Control of a Two-CubeSat Virtual Telescope in Highly Elliptical Orbits	Attitude Control, Extended Kalman Filter, Orbital Mechanics, CubeSat	**Reza Pirayesh**, Asal Naseri
30	Nanoscience and Microsystems Engineering	Coupled two-phase flow and membrane mechanics models for nanoimprint lithography	Nanoimprint Lithography, Reynolds Lubrication, Multiphase, Gas-liquid, Dissolution	**Andrew Cochrane**, Kristianto Tjiptowidjojo, Roger T. Bonnecaze, P. Randall Schunk
31	Physics	Fundamental limits to the local density of photonic states	Local Density of Photonic States, Decay Rate, Sum Rule, Plasmons, Nanoparticles	**Stephen Sanders,** Alejandro Manjavacas

Oral Talk Session C

2:30pm-3:10pm | Santa Ana A&B

2:30pm-2:50pm Presentation by Raviteja Vangara

Solvation and Surface-component interactions effect on double layer structure and properties: Explicit Solvent Model and Surface Charge regulation

Raviteja Vangara, Frank van Swol and Dimiter Petsev
Department of Chemical Engineering

Electric double layers are formed when an electrolyte solution is exposed to a charged interface. The charged interface exerts a bulk potential across the interface leading to the redistribution of dissolved solute components and solvent molecules. Previous theories such as continuum models are based on approximating solvent as a structureless continuum however our analysis demonstrates that considering solvent structure presents counterintuitive understanding on the composition of inner Helmholtz plane as well as stern layer. We present a computational model in treating solvent explicitly, that is, using statistical mechanical models we compute all interactions of dissolved electrolytic components with solvent molecules and also with the external field exerted by charged surface. This analysis is done using classical density functional theory. Unlike the usual constant potential and constant charged surfaces known as Dirichlet and Neumann boundary conditions, we employ Surface charge regulation boundary condition which is that the surface charge is governed by chemical reaction between potentia determining ions and surface reactive groups. The study of electric double layers is important in the fields of Colloidal electrostatics, fundamentals of electrochemistry and Corrosion science.

2:50pm-3:10pm Presentation by Kate Reinhart

Targeting the vulnerable phase of spreading depolarization with ketamine does not prevent plasticity mechanisms

K.M. Reinhart, R.J. Oliver, G. Perales, N.I. Perrone-Bizzozero, C.W. Shuttleworth
Department of Biomedical Sciences, Neuroscience

Spreading depolarizations (SD) are slowly propagating waves of neuronal depolarization that occur in stroke brain. SD causes irrecoverable injury to metabolically compromised tissues by over-excitation of NMDA receptors. However, SD may also promote NMDA receptor-dependent synaptic plasticity and protective preconditioning in healthy tissues surrounding infarcts. We tested whether low concentrations of the NMDA receptor antagonist ketamine can prevent injury, without blocking potential beneficial effects of SD. Acute mouse brain slices were used to monitor SD optically and electrophysiologically. BDNF mRNA was assessed by rt-qPCR. In healthy brain slices, 30µM ketamine preserved SD initiation, reduced the duration of SD ($P<0.01$), and did not prevent synaptic potentiation ($P=0.14$). In separate experiments, total BDNF (BDNF-Pan) and activity-dependent BDNF (BDNF-L) mRNA from slices was assessed, and both forms of BDNF increased after SD ($P<0.01$). Ketamine did not prevent these increases ($P=0.15$, and $P=0.37$ for BDNF-Pan and BDNF-L, respectively). We next evaluated metabolically compromised slices, and found that ketamine protected against SD injury and tissues recovered the ability to generate repetitive SDs. These findings suggest that low ketamine concentrations can protect against damaging effects of SD while permitting propagation into peri-infarct regions. Such SDs could contribute to protective preconditioning and support recovery and repair.

Guest Speaker

3:20pm-3:50pm | Santa Ana A&B

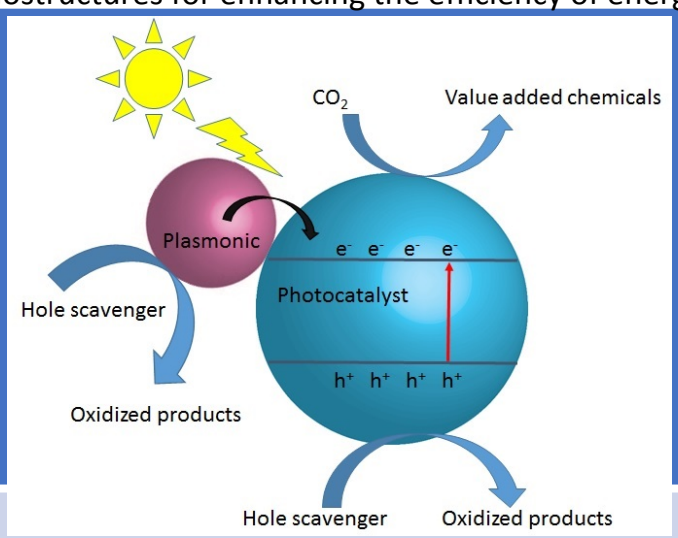
Dr. Sanchari Chowdhury

Assistant Professor

New Mexico Institute of Mining and Technology

Optically Active Nanostructures and its Applications in Energy Conversion

Metallic nanostructures can concentrate incident light as much as 1000 times in the near-field due to localized surface plasmon resonance. The Strong electromagnetic field at the surface of metallic nanoparticles can be utilized to manipulate the energy and electron absorption of vicinal molecules. I will talk about the application of these optically active metal nanostructures for enhancing the efficiency of energy conversion.



Dr. Sanchari Chowdhury received her Ph.D. degree in Chemical Engineering from the University of South Florida in 2010, and then worked as a postdoctoral research associate in the Chemistry Department at Carnegie Mellon University. In 2015, she joined the faculty of the Chemical Engineering Department of the New Mexico Institute of Mining and Technology, where she has served as both an Assistant Professor and a Principle Investigator for the Photonics and Plasmonics Nanoresearch Laboratory.

Her main research interests are in the plasmonic properties of noble metal nanoparticles (NPs) and their applications in the areas of energy conversion and biological detection, and as such she has developed a new course focused on fundamental properties of nanomaterials which she teaches to both graduate and undergraduate students at New Mexico Tech.

In 2017 she was the recipient of the Distinguished faculty award from New Mexico Tech as recognition of her excellent work within the department of Chemical Engineering. She has published over fourteen peer reviewed journal articles and has one patent. She has also been an invited speaker at several conferences and symposiums including AIChE's annual conference and Materials Research Society Meeting.

Oral Talk Session D

4:00pm-4:40pm | Santa Ana A&B

4:00pm-4:20pm Presentation by Kristen Rahilly

Diffuse carbon dioxide flux measurements as evidence for hot dry rock geothermal system viability

Kristen Rahilly, Tobias Fischer, Stuart Simmons
Department of Earth and Planetary Sciences, Utah FORGE project U.S. Department of Energy

Southwestern Utah is home to one of two finalists for the Department of Energy's Frontier Observatory for Research in Geothermal Energy (FORGE) program for development of hot dry rock geothermal systems. The prospective FORGE site in Utah is underlain by rocks with a temperature of at least 175°C at 4 km depth. However, unlike classic geothermal systems, the site in Utah is dry and unfractured, limiting the possibility of heat traveling to the surface. Hot dry rock geothermal systems require the overlying rock to be synthetically fractured. Water is then pumped into the subsurface, allowing the heat from rocks at depth to be used at the surface for energy. Factors that could decrease the viability of a site are naturally found faults as well as rocks that have been weakened by alteration due to nearby volcanic activity. I use surficial point measurements of carbon dioxide flux emitted from soil to help determine the viability of the Utah FORGE site. Variations in carbon dioxide flux can reveal hidden faults that more effectively funnel carbon dioxide to the surface. The isotopic composition of gas samples collected throughout the site indicates whether the carbon dioxide is from biological or volcanic sources. Over 1100 point measurements of carbon dioxide flux have been made across the Utah FORGE site and suggest that the site is very well contained with little to no natural faults or volcanic input.

4:20pm-4:40pm Presentation by Phuong Anh Nguyen

Developing a pH responsive hydrogel for colonoscopy preparation

Phuong Anh H Nguyen, Darnell Cuylear, Heather E. Canavan
Department of Biomedical Engineering

Colorectal cancer (CRC) is the second leading cause of cancer death in the United States. The most reliable screening method of CRC is a colonoscopy, yet 58% of all patients are nonadherent to the schedule for a colonoscopy due to discomfort in association with the preparation. The standard colonoscopy preparation technique is to drink 4L of poly(ethylene glycol) electrolyte lavage solution (PEG-ELS) the night prior to the procedure. This solution is often characterized as foul tasting with side effects of nausea, vomiting, abdominal bloating, abdominal pain, rectal irritation, etc. An alternative to this negative experience is the use of a hydrogel with the drug encapsulated inside. We are working on developing a hydrogel system to encapsulate PEG-3350 with electrolytes, and antiemetics. Currently, the hydrogel is adapted from a chitosan/alginate system that delivers drugs to the small intestine. Initial studies show drug release at low pH with further studies to be completed at higher pH representative of small intestine and the large intestine.

Poster Abstracts

1. Medicinal Plant Extraction and Analysis

Shania Sanchez, Victor French, Tracy J. Terry
Department of Biochemistry, Title III STEM grant

We have begun a survey of the medicinal properties of common plants of the southwest. For this study, steam distillation for essential oils have been carried out on various locally sourced plants. These extracts have been analyzed for antimicrobial properties via Kirby-Bauer assay using Escherichia coli and Staphylococcus aureus on Mueller Hinton agar. Zones of inhibition were analyzed and compared to a Ciprofloxacin control and a blank BBL disk. Extracts have shown antimicrobial properties via Kirby-Bauer assay. Other assays for biological activity will be conducted in the future. As active agents are identified, further isolation and analysis of compounds for possible synergistic effects will occur.

2. Encapsulation of Poly(Ethylene Glycol) in a Smart Hydrogel for Colonoscopy Preparation

Darnell Cuylear, Phuong A.H. Nguyen, Heather Canavan
Department of Biology

Colorectal cancer (CRC) is the second leading cause of cancer death in the United States. The most reliable screening method of CRC is a colonoscopy which requires a 4L electrolyte lavage solution with poly(ethylene glycol) (PEG-ELS) for preparation. Approximately 58% of patients are non-compliant to their colonoscopy schedules with many patients who obtain reporting refusal due to significant discomfort associated with this prep. An alternative to this negative experience is the use of a hydrogel with the drug encapsulated inside. A novel hydrogel system, no larger than the typical over the counter drug, by cross linking chitosan and alginate to encapsulate PEG-3350 have been developed to reduce patient discomforts. Various pH release test ensures these chitosan-alginate hydrogels are pH responsive and swell to release PEG-3350 and other contents into pH environments similar to those found in the stomach (pH 1.5-3.5). Biocompatibility of hydrogel components were assessed using Bovine Aortic Endothelial Cells.

3. TNF-α priming regulates CD82 expression and Bone Marrow Homing of Hematopoietic Stem and Progenitor cells

Erica M. Pascetti, Christina M. Termini, Muskan Floren, Jennifer M. Gillette
Department of Biomedical Sciences

Hematopoietic stem/progenitor cell (HSPC) transplantation is a primary clinical therapy for the treatment of blood cancers, immunodeficiency disorders, and high-dose chemotherapy patients. For effective HSPC transplantation, stem cells must traffic through the blood and home to the bone marrow, which provides support and instructional cues to balance stem cell properties. Despite the clinical successes of HSPC transplantation, the molecular mechanisms that regulate HSPC trafficking remain unclear. Tetraspanins are molecular scaffolds that function to organize adhesion and signaling proteins into membrane microdomains, which impacts cell adhesion and signal transduction. Our previous work identified the tetraspanin, CD82, as a regulator of HSPC adhesion and bone marrow homing. Therefore, we hypothesize that the upregulation of CD82 expression may promote bone marrow homing and improved transplantation. In the current study, we describe the use of tumor necrosis factor α (TNFα) to modulate CD82 expression on the surface of HSPCs. A dose response analysis of TNFα primed HSPCs identified a significant increase in the surface expression of CD82. Additionally, we find that HSPC TNFα priming promotes increased cell adhesion. Finally, our data suggest that TNFα priming of HSPCs enhances bone marrow homing of HSPCs in preclinical animal models. Together, we anticipate that these studies have the potential to offer new molecular targets and treatments to improve HSPC transplantation.

4. Altered expression of angiogenesis-associated miR-150-5p and its target Vezf1 in mouse models of prenatal alcohol exposure

Gabriela Perales,
Amy S. Gardiner, Kevin K. Caldwell, Andrea M. Allan, Nora I. Perrone-Bizzozero
Department of Biomedical Sciences

Fetal alcohol spectrum disorders (FASD) occur in children whose mothers consumed alcohol during pregnancy. Prenatal alcohol exposure (PAE) is difficult to diagnose because problems start to arise as the child develops over time, leading to developmental disabilities. These deficits can be caused by alterations in gene expression that are regulated by microRNAs (miRNAs). miRNAs are small non-protein-coding single-stranded RNA molecules that silence gene expression by binding to targeted mRNAs and prevent translation. Using a mouse model of PAE, we performed sequencing of circulating miRNAs from the plasma of pregnant dams. Among the miRNAs most altered of alcohol-exposed dams was miR-150-5p. We also collected the cortices of PAE pups at embryonic day 18 (E18) and found that miR-150-5p was significantly increased in the PAE cortices. Recent literature suggests that miR-150-5p regulates angiogenesis during embryonic brain development. We identified a novel putative target of miR-150-5p, vascular endothelial zinc finger 1 (Vezf1), which is an endothelial-specific transcription factor required for normal vascular development. Using RT-qPCR, we found that Vezf1 was significantly decreased in the same PAE cortices. We hypothesize that miR-150-5p regulates Vezf1 expression during development, resulting in alterations to the brain vasculature during PAE. Continuing studies will provide insight into miRNA-mediated mechanisms that contribute to the teratogenic effects of PAE.

5. Default patterning produces pan-cortical glutamatergic and CGE/LGE-like GABAergic neurons from human pluripotent stem cells

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Here we performed a transcriptome analyses on human pluripotent stem cell-derived neurons (hPSNs) that underwent default differentiation. Bioinformatic analyses between *in vitro* hPSNs and *in vivo* human samples were performed to characterize the diversity of neuronal specification. Temporally, day 50 hPSNs resembled mid-gestational fetal brains and express a plethora of functional mRNA species characteristic of both glutamatergic and GABAergic neurons. Transition Mapping analysis indicated a pan-cortical identity of hPSNs, with expression of multiple cortical layer genes. Interestingly, CoNTExT analysis identified a subpallial transcriptional profile, shown by expression of genes specific for GABAergic neurons. Comparing markers known to segregate between subpallial domains *in vivo*, we found that the majority of expressed genes showed significant overlap with those found in the caudal and lateral ganglionic eminences (CGE/LGE). Accordingly, immunocytochemical staining revealed a large subset of progenitors expressing the CGE marker COUPTFII. Further, approximately forty percent of post-mitotic neurons stained positive for the CGE marker CALB2. Taken together, our data point to the simultaneous generation of both cortical glutamatergic and subpallial GABAergic neurons that resemble those derived from CGE/LGE. These data reveal a previously unreported specification pattern within default-derived cultures and provide a resource to guide future directed differentiation strategies.

6. The effect of germline polymorphisms on somatic hotspot mutations in TP53 for the treatment of High Grade Serous Ovarian Carcinoma

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Introduction:
Due to frequent recurrences and acquired resistance to platinum-based chemotherapy in high-grade serous ovarian cancer (HGS OvCa), it is important to identify novel targets and pathways to overcome drug resistance and improve the outcome of patients with ovarian cancer. TP53, which encodes the transcription factor p53, is mutated in 96% of HGS OvCa . Majority of the studies that establish the relationship between mutations in TP53 and cancer have focused on hotspot somatic mutations. In addition to somatic mutations, non-synonymous germline single nucleotide polymorphisms (SNPs) at codon 72 play a role in altering the function of TP53 and a cancer susceptibility. However, the effect of codon 72 (P72R) polymorphism on somatic mutations in TP53 is not well characterized with regard to the Epithelial to Mesenchymal phenotype and cancer progression.
Objective:
-Characterize the effect of somatic mutations in TP53 in the presence of the P72R SNP on cellular morphology and cancer progression.
Summary:
- The hotspot missense mutants with R72 have a greater growth potential in comparison to their P72 counterpart which could explain the pro-carcinogenic effect of the former.

7. Gel encapsulation of Mel28 cells using DEX/E3 water-water system

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Aqueous two-phase systems using protein and glucan have potential for droplet generations which in turn can be used to encapsulate spherical cells with further implications for 3D biological printing. The phase-separation being investigated includes a mixture of Dextran and E3. This water-soluble solution phase separates once a critical concentration of Dextran and E3 has been obtained. This process is Thermodynamically driving which is temperature dependent. The fluid can then be put into a capillary device in which droplets are formed. E3 acts as a gel pursuer for the microdroplet. The outer microdroplet layer is protein-rich and the inside contents is Dextran-rich. Using this type of water-water interactions will allow for a cell to be encapsulated within the protein gel with the use of crosslinking. This environment is cyto-friendly and due to the cross-linkage creates more attractive mechanical properties. Using E3 as the precursor, within the water-water system, will also create a great platform for 3D printing biological due to the stability and degradation of the protein. Thus, this research will be important towards mass printing biological material.

8. Photochromic Polypyridyl Ruthenium Sulfoxide in Photofunctional Materials

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Continued research and development of photorefractive (PR) materials is important to the development and implementation of 3-D information storage. Information storage in PR materials has been demonstrated by multi wave degenerate mixing, where the signal wave encodes information and reference wave encodes phase. Traditional research of PR materials has focused on the development of PR single crystals and ternary polymer mixtures, which by definition contain an electro-optical charge migration. Alternatively, the Kramers-Kronig relation predicts that materials that feature large changes in absorbance (or transmittance) should also exhibit large changes in the refractive index. However the development of such materials has not been widely explored. Photochromic compounds exhibit a reversible transformation in their electronic structure between two isomeric forms (A to B). Herein, we demonstrate that photochromic polypyridyl ruthenium sulfoxide molecules incorporated within simple polymer materials are a new class of photofunctional materials for 3-D information storage.

9. Modeling Cascading-Failures in Power Grids Including Communication and Human Operator Impacts

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Most studies on cascading-failures in power grids have focused on modeling dynamics in a single, non-interacting power system. However, a few recent studies have suggested that communication networks and human operators' response also play pivotal roles during cascading-failures in modern smart grids. We proposed a comprehensive three-layer model for capturing cascading-failure dynamics that considers the inter-dependency among the three-layers', i.e., power grid, communication network and human factors. The cascading-failure dynamics is characterized based on a Markov chain model. Specifically, in this model, cascading-failure dynamics in the power grid capture the internal dynamics of the power grid as well as performance and connectivity degradation in the communication network and the human errors through the Markov chain abstraction. The proposed model has the capability to analyze how inter-dependencies among the three-layers impact cascading-failures. Modeling of cascading failures in IEEE 118-bus system demonstrates the impact of communication network and human-operator response on power grid cascading-failures. A key insight obtained from the proposed three-layer model is that inter-dependencies among reliable systems, i.e., systems with exponentially distributed failure sizes, can make the overall system behave unreliably, as evidenced by power-law distributions for the overall system while individual layers exhibited exponentially distributed failure sizes.

10. Resolution Enhancement For Optical Microscopy

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Department of Electrical and Computer Engineering

Microscopy is a widely used technique for viewing very small objects that cannot be seen by an unaided eye. It is also one of the oldest applications of optical science. In the case of conventional microscopy, every lens acts as a low pass filter and restricts the frequency space coverage to 2NA/λ (where λ is the wavelength of the light source and NA is the Numerical Aperture of the lens) and hence resolution to 0.5 λ/NA. Using a 532nm source and 0.4 NA lens, maximum achievable resolution limit according to Rayleigh is only around 650nm. Therefore to increase frequency space coverage and resolution limit we are developing an Imaging Interferometric Microscopy technique. This is a synthetic aperture approach that uses off axis illumination on a transparent solid substrate. This technique increases resolution to 0.5* λ/(1+n) (where n is the substrate refractive index). An extension of the resolution limit to 150nm has been achieved so far by using a glass substrate (n=1.5). Further extension of resolution limit below 50nm has been projected using a thin silicon superstrate that has a higher refractive index (n=4.5). This technique will be useful for metrology and also for biological research and other applications.

11. Radial Head Instability and Limited Hand Rotation after IOM Injury

Jodie Gomez, Tom Pollard, Drew Newhoff, Erica Gauger, Jorge Orbay, Deana Mercer, Christina Salas
Department of Mechanical Engineering

The interosseous membrane (IOM) is a key stabilizer of the forearm, often injured due to trauma. We sought to determine the IOM structures' role in maintaining forearm stability at the radial head by measuring the change to its intact motion caused by ligament sectioning. We used 14 cadaveric specimens. A custom fixture supported the arm and hand with the elbow flexed 90 degrees and simulated active muscle loading to rotate from a neutral position to full supination and full pronation. A 10-camera Optitrack motion capture system tracked the motion of the radius for several stages of sequential sectioning: intact IOM, annular ligament sectioned, proximal band sectioned, central band sectioned, and distal band sectioned. The position and orientation data of each sectioning stage was compared to the neutral forearm position of the intact stage. In pronation, the radial head relative displacements were not significantly different for any sectioning stage. In supination, the radial head moved anterolaterally, increasing displacement with all sequential sectionings. After sectioning the central band, maximum hand rotation decreased from a mean of 36 degrees to 4 degrees. Central band sectioning had the greatest effect on radial head translations, changing the biceps' role from flexor/supinator to exclusively a flexor.

12. Effect of Cr Content on the Phase Stability of Ferritic/Martensitic Steels under Neutron Irradiations at FFTF

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Department of Mechanical Engineering

We have investigated the phase stability in 9-12 Cr ferritic/martensitic (F/M) steels using TEM based technique. F/M steels including HT-9 (12% Cr), HT-9 modified (10%Cr), and T-91 (9%Cr) were previously irradiated as part of materials open test assembly (MOTA) experiments at fast flux test facility (FFTF) up to 184 displacement per atom (dpa) at a temperature of ~413˚C. While Cr rich α' precipitates were only seen in HT-9, G-phase precipitates were seen in all the samples but varied in stoichiometry, density, and average size according to chemical composition of alloy and total dpa damage. Voids formed in T-91 (184 dpa) and parts of HT-9M (139 dpa), but not in HT-9 (38.3 dpa). The non-uniformity of the void distribution in HT-9M was attributed to variation in the micro structure.

13. Resolving inter-chromophoric coupling in tetrakis(perylene diimide) complexes

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Department of Nanoscience and Microsystems Engineering

Efficient electronic communication is paramount for organic electron acceptors in photovoltaic roles, but disastrous in catalytic applications, making understanding inter-chromophoric excited state interactions vital for informed molecular design.
Two structural variants of tetrakis(perylene-diimide) spirobifluorene are investigated to determine inter-chromophoric coupling changes as a function of the number of bonds joining each perylene diimide (PDI) to the spirobifluorene center. One variant has two bonds between each PDI and the center, which holds the molecule in a 'rigid' conformation. We call the other variant 'floppy' because there is a single bond between each PDI and the center, letting each chromophore rotate.
We can take advantage of the step-like fluorescence behavior of single emitters to determine the amount of chromophore coupling in each tetrakis molecule, since isolated chromophores emit independently. Widefield fluorescence microscope images of single-molecule dispersions are analyzed to yield large data sets of single molecule intensity 'trajectories'. Rigid tetrakis(PDI) molecules demonstrate less intermittent time-dependent fluorescence intensity behavior than floppy molecules under the same excitation. To explain this finding, we propose that each half of the rigid molecule (2 PDI monomers) may act as a single chromophore that exhibits more stable emission than the PDI monomers alone.

14. Charge-transfer plasmons in particle-substrate metallic systems

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Understanding how the plasmonic response of metallic nanoparticles is modified by the interaction with metallic substrates is of paramount importance due to the large potential of these systems for applications in biosensing, solar energy harvesting, and photochemistry. However, current understanding of the properties of these systems is mostly limited to situations in which the nanoparticles are located near but not in contact with the metallic substrate. Here, we investigate the optical response of gold nanorods in conductive contact with gold substrates. We find that the optical response of these systems is dominated by a charge-transfer plasmon mode, where charges flow into and out of the particle through the substrate. The properties of this mode are dictated by the characteristics of the particle-substrate junction, which are largely dependent on the crystalline structure of the nanoparticle, as well as the conductance of the junction. This makes this charge-transfer plasmon mode far less sensitive to the nanoparticle size and geometry than a typical dipolar plasmon mode. The results of this work serve to advance our understanding of the interaction between metallic nanoparticles and substrates, as well as provide a method for creating more robust plasmonic platforms, which are less affected by changes in individual nanoparticle geometry.

15. Effect of processing techniques on electrical, thermal, and mechanical properties of 14YWT

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In this study, two processing techniques, Hot Isostatic Pressing (HIP) and Hot extrusion (ER), were used to investigate their effect on electrical resistivity and thermal conductivity of 14 YWT. The effects were investigated by microscopy and characterization techniques including Scanning Electron Microscopy (SEM), Focused Ion Beam (FIB) and transmission electron microscopy (TEM) and, conductivity techniques including low-frequency ac resistance bridge and laser flash apparatus (LFA). It is observed that the density of grains decreases by increasing the HIP temperature. This can be seen by the increase of average grain size from 0.99156 µm to 2.13116 µm for HIP 850 C and HIP 1150 C respectively. The ER process elongates the grains to an average size of 1.3666237 µm along the extrusion direction. The intrinsic resistivity was found to be highest for ER 850 C, followed by HIP 850 C, and least for HIP 1150 C demonstrating the effect of grain boundary scattering of electrons. The thermal conductivity results obtained exhibit a similar trend except for data collected between 975 and 1075 K. The results of this work suggest that the thermal conductivity of 14YWT will remain essentially constant as a function of the heat treatment. Nanoindentation was used to compare differences between hardness of small grains and big grains. This study indicates crucial effect of preliminary microstructure on the electrical, thermal, and mechanical properties of 14 YWT.

16. Formation of γ' Precipitates in Alloy 718 Under Irradiation Environments

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Department of Nuclear Engineering

During a preventive maintenance at the Los Alamos Neutron Science Center (LANSCE) Isotope Production Facility (IPF), a beam window made of solution annealed Alloy 718 was replace and the old beam window was analyzed. The old beam window underwent mechanical testing and microstructure analysis. During the microstructure analysis, the formation of γ' precipitates was observed in the Transmission Electron Microscopy (TEM) electron diffraction patterns for some of the samples. The formation of γ' precipitates was not expected. The formation of γ' precipitates was observed at temperature of 33ºC, at a displacement per atom (dpa) of 0.7 with energetic H+ ions. Recent testing at Sandia National Lab (SNL) Ion in situ TEM lab (I3TEM) tried to map out the temperature and dose rate that γ' precipitates will form. The first test was conducted with Ni ions at room temperature up to a dpa of 1.4. The test results concluded that γ' precipitates do not formed under these conditions. Another test was conducted with Au ions at 200 ºC came up with the same null findings. Current investigation into energy deposited with Monte Carlo N-Particle Code (MCNP6) and The Stopping and Range of Ions in Matter (SRIM) to compare if energy deposited is the contributing factor for formation of γ precipitates. Further tests are being planned to investigate Alloy 718 with H+ ions at a constant temperature of 33ºC and pursing higher dose rates.

17. Surface plasmon polariton beams with flat top profiles

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Flat top beams, which are characterized by their square profile shape and uniform intensity, are well known in the context of paraxial optical beams, but have remained unexplored in the area of surface plasmon polaritons (SPPs). SPPs are collective oscillations of the conduction electrons in a metallic material coupled to electromagnetic waves, and have emerged as ideal platforms for the manipulation of light below the diffraction limit. These excitations propagate for hundreds of wavelengths while remaining confined to a small volume around the interface between the metal and its surrounding dielectric environment. Here, we introduce and characterize, for the first time, SPP beams that have flat top profiles. This is accomplished by using a set of SPP Hermite Gauss modes forming a complete basis for the solutions of Maxwell's equations for a metal-dielectric interface in the paraxial approximation. We perform a comprehensive analysis of the evolution of the shape and intensity of these flat top beams over propagation distances of hundreds of wavelengths. This introduction of flat top beams to SPPs brings a new element to the SPP toolbox that can enable unique excitation and coupling scenarios that are not possible with conventional SPP profiles.

18. Cell Type-Specific Response to Spindle Misorientation and Effects on Tissue Growth

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Controlled cell growth and proliferation are essential for proper animal development. These must be coordinated with cell polarity and mitotic spindle orientation to ensure correct tissue morphology. Mitotic errors have been associated with aberrant tissue growth in both epithelial cells and stem cells. For instance, mutations in cell cycle-promoting genes in neural stem cells cause a mild increase in the Drosophila central nervous system (CNS). Conversely, identical mutations in Drosophila imaginal wing discs (IWD), terminally differentiated cells, lead to massive tissue overgrowth. Additionally, spindle misorientation leads to an increase in stem cell number and overall CNS size, whereas growth is restricted in IWDs. The mechanisms underlying the differential responses of these cells to errors in cell division, however, are unknown. Here we seek to build a stem cell model and a differential cell model to elucidate the varied tissue- specific responses. We found that epithelial tissue experiences increased apoptosis in response to spindle orientation defects and growth promoting pathways. Furthermore, we found that similar mutations result in increased CNS size but no significant change is observed with spindle misorientation. Further analysis will provide a better understanding of the signaling pathways that govern tissue level responses to defective cell division, both of which are important in understanding the underlying molecular bases for numerous human diseases.

19. Recent evolution of the *Mycobacterium tuberculosis* genome

Julie Allison Spencer
Department of Biology

Tuberculosis (TB) is currently the ninth leading cause of death for humans worldwide, causing 10.4 million new infections in 2016. Of these infections, 490,000 were multidrug resistant (WHO, 2017). The potential for emergent epidemics of drug resistant TB highlights the need to understand evolutionary mechanisms leading to antimicrobial resistance and horizontal gene transfer in the *M. tuberculosis* (*MTB*) genome. In this study, I asked whether clusters of proteins related to these functions have been lost or gained by the *MTB* genome since the common ancestor of *M. tuberculosis* and *M. canetti*. MUSCLE and Aliview were used for alignments. RaxML was used to infer a phylogenetic reference tree. The SEED protein cluster tools were used to identify protein families gained or lost. SplitsTree was used to identify signals of recombination. I found that families of integrase, phage integrase, and DNA primase are present in current *M. tuberculosis* genomes, but not present in closely related strains *M. bovis* or *M. canetti*. In its adaptation as a human pathogen, *M. tuberculosis* may have gained multiple replication and recombination functions.

20. Comparing Synthesis Methods of Oligo (poly (ethylene glycol) fumerate) for Heart Valve Tissue Engineering

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Department of Biomedical Engineering

Aortic heart valve disease affects approximately 1.5 million Americans, resulting in reduced pumping efficiency and oxygenated blood flow throughout the body. Populated by valvular interstitial cells (VICs), the aortic heart valve is comprised of three, compliant valve leaflets which open and close controlling the unidirectional flow of blood through the circulatory system. In order to produce a tissue engineered heart valve for the replacement of the aortic valve, current technology focuses on the growth and differentiation of VICs in three dimensional (3D) hydrogels. However, current scaffolds are insufficient for the controlled growth of VICs. In order to overcome the limitations of current replacement options, our group has developed a novel synthetic routs for producing the degradable polymer, oligo (poly (ethylene glycol) fumerate) (OPF). Using nitrogen sparging, OPF can be produced faster, cleaner, and results in a larger macromolecule which can then be functionalized with adhesive ligands and signaling molecules for tissue engineered studies.

21. Enduring pathological effects of prenatal alcohol exposure on touch hypersensitivity following peripheral nerve damage via neuroimmune mechanisms

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Allodynia (hypersensitivity to light mechanical touch) is a clinical neuropathic pain condition shown to be mediated by activated spinal glia (astrocytes and microglia) and proinflammatory cytokines. Allodynia can me modeled in rats by a chronic constriction injury (CCI) of the sciatic nerve. We recently demonstrated that young prenatal alcohol exposed (PAE) rats develop potentiated hindpaw allodynia following CCI and show elevated spinal glial activation. The goal of the current study was to determine following PAE (1) if the pain effects are enduring, (2) whether a less severe CCI injury (1-suture model) produces allodynia and (3) whether PAE alters glial function and peripheral immune responses. To do this, one year male PAE and Saccharin control rats were assessed for allodynia prior to and after either 4-suture or 1-suture CCI or sham surgery. Immunohistochemical detection was used to determine spinal glial activation. ELISA was used to determine cytokine expression in cells from surgically naïve PAE and Saccharin rats. Results show 4-suture CCI potentiated allodynia in PAE rats while less severe CCI generated unilateral allodynia only in PAE rats. Spinal glial reactivity was greatest in PAE rats with 4-suture CCI. Interestingly, 1-suture CCI resulted in alteration of astrocytes but not microglia. LPS stimulation resulted in exaggerated expression of proinflammatory cytokines in cells from PAE rats. These results indicate PAE creates enduring susceptibility to neuropathy with potentially distinct neuroimmune mechanisms.

22. Increasing Neural Activity in the Orbitofrontal Cortex Using Optogenetics After Prenatal Alcohol Exposure

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Moderate alcohol consumption during pregnancy can negatively impact behavioral flexibility in adult offspring. We have previously shown in mice that moderate prenatal alcohol exposure (PAE) during gestation impairs flexibility on a touchscreen reversal learning task. Both single unit and local field potential (LFP) recordings show that PAE decreased neuronal activity in the orbitofrontal cortex (OFC) during early reversal. Here, we investigated whether optical stimulation of neurons in the OFC would restore normal function in PAE mice. We also examined the effects of PAE on parvalbumin (PV+) interneurons. After training, PAE and control (SAC) offspring received a viral vector (channelrhodopsin or fluorescent control) and a recording optrode into the OFC. Four weeks post-injection, mice were reminded of the task and contingencies were reversed to test behavioral flexibility. During reversal sessions 1-4, where PAE mice are shown to be most behaviorally inflexible, mice received light stimulation one second after making a correct choice. In a separate cohort, 50µm thick brain slices were stained for PV+ cells for stereological counting. We found that light stimulation during early reversal improved performance in ChR2+ PAE mice compared to SAC. We also found there to be a reduction in the number of PV+ cells in PAE compared to SAC mice. These data provide evidence that activation of neuronal populations may aid in value updating and increase behavioral flexibility in PAE mice.

23. Design and Synthesis of a Zwitterionic Metal-Organic Framework for Selective Gas Adsorption

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Department of Chemistry

Zwitterionic microporous MOFs are extremely attractive for gas adsorption because of high available pore volume and absence of counter ions. Herein, we report the construction of a zwitterionic 3-dimensional framework by coordinating tetrahedral borate-pyridine ligand to copper metal in +1 oxidation state. The resulting Cu(I) MOF was four-fold interpenetrated with significantly higher BET surface area of 620 m2/g and high stability to moisture as well as heat. At 1 bar pressure and different temperatures (273 K, 298 K, 303 K and 313 K), activated sample of Cu(I) MOF adsorbed both N2 and CO2 gas with higher uptake of CO2 over N2. Furthermore, the selectivity of CO2 over N2 was evaluated by ideal adsorbed solution theory (IAST) and Henry's method. At 1 bar pressure and 313 K, Cu (I) MOF showed good IAST selectivity value of 107 for CO2/N2 (15/85). The isosteric heat of CO2 adsorption at zero coverage was 15.85 KJ/mol confirming the pure physical interaction of Cu(I) MOF during adsorption. The high CO2 uptake at 313 K, excellent thermal plus water stability and reasonable isosteric heat of adsorption make Cu(I) zwitterionic MOF a potential physical adsorbent for CO2/N2 separation at low pressure.

24. Ni-catalyzed 1,2 Dicarbofunctionalization of Unactivated Olefins and its Application to the Synthesis of Lignan Natural Products

Shekhar KC, Prakash Basnet, Surendra Thapa, Bijay Shrestha, and Ramesh Giri*
Department of Chemistry

Dicarbofunctionalization of unactivated olefins using a transition metal (TM) catalyst via cyclization/cross-coupling could afford a straightforward synthetic route to complex carbon scaffolds relevant to natural products, bioactive molecules and pharmaceuticals. However, interception of C(sp3)-M species, which are generated as intermediates in catalytic reactions, is a formidable challenge due to their high propensity to undergo b-H elimination that leads to the formation of Heck products. Herein, we report a Ni/terpyridine catalyst that overcomes this challenge and enables to difunctionalize unactivated olefins with alkyl halides and aryl zinc reagent regioselectively. This reaction tolerates a wide variety of functional groups and base-sensitive racemizable stereocenters. This reaction protocol also provides rapid access to (arylmethyl)carbo- and heterocyclic scaffolds, which occur widely as structural cores in various natural products and bioactive molecules. We further applied this new method for the concise synthesis of six lignan natural products containing three different structural frameworks in gram-scale quantities. Mechanistic studies with radical probes and product selectivities show that the current reaction proceeds via a single electron transfer (SET) process.

25. Machine Learning classifiers applied in event-based sensor: DVS128

Xiaomeng Li, Fernando Moreu
Department of Civil Engineering

Machine Learning algorithms have been applied in different computer science areas and made great success in recent years. In this paper, the authors will first introduce an impact experiment. The authors used event-based sensor DVS128 and high-speed camera to record this experiment. Second, the authors will use three different classifiers: Logistic Regression, Super Vector Machine and Neural Network to train the event-based sensor's data in order to classify the deformation of the impacted structure. The results from these three classifiers will be outlined. Third, the author will introduce the process of Neural Network training and testing with TensorFlow.

26. Measuring Liquid Properties on Nano-scale Photoresist 1D Patterned Structures

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Directional wetting is a desirable materials property, particularly in the context of self-cleaning surfaces. Nature provides some very sophisticated strategies for the implementation of directional wetting. Micro-structured surfaces have been studied to explain wetting as a function of surface chemistry . Experimental studies of directional wetting on 1D patterned surface have been reported for large micron-scale features, so far nanoscaled grooves are relatively unexplored. Molecular dynamics simulations have focused on wetting on nanoscale groove-patterned surfaces. Nanoscale molecular models are highly dependent on the contact line pinning near plateau edges and computationally involve only a small number of atoms. Both directions have shown a small penetration of liquid on the grooves and deviation from the predicted Wenzel (liquid penetrates spaces between grooves) and Cassie-Baxter (liquid suspended above the groove) models. Both the Cassie-Baxter and Wenzel Models were formulated for randomly rough surfaces and break down when drop sizes are much larger that the patterned sizes . This experiment is intended to bridge the difference between the micrometer scale micro-fluidic experimental results and nanoscale wetting simulations with showing experimental data on liquid drop statics and dynamics on nanoscale periodic surfaces.

27. 3D Bioprinting+Electrospinning Hybrid System for Functionally-Graded Scaffolds of the Bone-Ligament Interface

Christopher Buksa, Steven Nery, Darielys Morales, Fermin Prieto, Ava Mauser, Chanju Fritch, Christina Salas
Department of Electrical and Computer Engineering

3D bioprinting has been introduced as a viable additive manufacturing technique for tissue engineering applications because it allows for patient-specific reconstruction of damaged hard and soft tissue. A current limitation to bioprinting is that the printed material has poor tensile characteristics. Electrospinning, an alternative deposition technique, has been show to produce high tensile scaffolds for ligament tissue engineering. We hypothesized that a custom built 3D bioprinter + electrospinner hybrid system would allow for targeted scaffolds of the bone-ligament interface such that the 3D bioprinter would allow for a functionally-graded transition from bone to ligament phases and the E-spun fibers would allow for high tensile loading needed for the ligament phase.
We introduce a custom hybrid 3D bioprinter + electrospinner built in our lab to facilitate layer-by-layer scaffold fabrication. Our bone and interface phases are 3D printed from Polycaprolactone (PCL) and hydrogel-based bioinks incorporating hydroxyapatite particles to optimize the mechanical properties and ensure a functionally-graded bone-ligament transition. The ligament phase is made from electrospun PCL fibers which enhance the structural integrity of the scaffold. We report preliminary findings of cell viability, migration, and proliferation. Additionally, we provide preliminary mechanical test data showing its potential for *in vivo* load bearing applications.

28. A Biomechanical Justification for Conservative Management of Partial Extensor Tendon Lacerations

Jasmin Regalado, Darielys Mejias-Morales, Benjamin Johnson, Jeremiah Johnson, Patrick Gilligan, Lauren Long, Deana Mercer, Christina Salas
Department of Mechanical Engineering

The current (anecdotal) indication for surgical intervention of extensor tendon injuries is a tear that exceeds 50% of the total width of the tendon. The goal of our study is to determine the threshold at which partial extensor tendon lacerations can be treated by conservative management. 15 cadaver hands were used for testing. For each hand, the index, middle, and ring fingers were lacerated with either 50-74% tear or 75-90% tear. Each finger was loaded with 25lb and cycled from full extension to flexion for 5,000 cycles to simulate post-operative motion. Each specimen was then loaded to failure. Tendons in both laceration groups experienced an insignificant drop in force (<0.5N). No specimens suffered complete rupture of the tendon during cyclic testing and no significant loss in range of motion. During failure testing, the tendons with 75-90% lacerations failed at an average of 61.9 N. The tendons with incisions that ranged from 50-74% did not experience complete rupture. We suggest that patients with lacerations of less than 75% can be conservatively managed (no surgical repair). However, patients with incisions of 75-90% should receive surgical intervention to avoid complete rupture of the tendon.

29. **Attitude Control of a Two-CubeSat Virtual Telescope in Highly Elliptical Orbits**

Reza Pirayesh, Asal Naseri
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The Virtual Telescope for X-ray Observations mission, VTXO, uses an innovative design based on diffractive optics with a Phased Fresnel Lens (PFL). The telescope elements (lens and camera) will be separately located on two 6U-Cubesats, flying in precision formation, to accommodate the required focal length. High resolutions of the images require the satellites to be in sub-arcsecond angular precision formation for the period of observation.

The orbits are designed so that the satellites can observe the Crab Nebula for one hour. There are 4 major phases involved. During the first phase, the open-loop formation, the two satellites pass the perigee without any control. In the development phase, the coarse pre-attitude control is applied to provide enough attitude accuracy for the scientific phase, during which the precision attitude control takes place, where the two satellites point at the Crab Nebula. In the last phase, an anti-gravity gradient torque is applied to the satellites to lessen the drift of the angular velocities from zero. In this study, an attitude control scheme, based on the quaternion model, is utilized. In the attitude control design of the system, the noises of different sensors are considered, and the navigation part of the control system uses an extended Kalman filter to estimate the attitude of the satellites. A sliding mode controller and a PD controller are implemented on the satellites and their efficiencies are compared with each other.

30. Coupled two-phase flow and membrane mechanics models for nanoimprint lithography

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Jet-and-Flash imprint lithography is a high-throughput process being developed to replicate nano-featured patterns over large areas. One of the crucial processing steps involves the merger of arrays of thousands of picoliter drops of photo-polymer as they fill and deform the the nano-featured template while also trapping and dissolving gas. Minimizing gas-trapping and achieving residual layer thickness uniformity are two challenges to reliable pattern replication.

This work implements a reduced-order model based on Reynolds' Lubrication theory that is extended with the concept of relative permeability for coarse grain simulation of two-phase drop merger over large areas. The model incorporates the physics of gas compression and dissolution that give rise to the gas trapping problem. Simulation results are compared to a flow visualization to demonstrate its capability to relate degree of gas trapping to imprint gap thickness.

Residual layer thickness non-uniformity is driven by conflicting capillary and lubrication forces and exacerbated by their increasing difference as the gap closes. The flow model is coupled with a shell membrane model to study how process parameters such as drop pattern, fluid properties and membrane stiffness affect the residual layer thickness that is formed by drops merging between a feature-less template and free-span tensioned web.

31. Fundamental limits to the local density of photonic states

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The strong near-field created by the plasmons supported by metallic nanostructures can be exploited to enhance the decay rate of quantum emitters placed nearby. Such enhancement is usually quantified by the local density of photonic states (LDOS). Here, we present a detailed analysis of the fundamental limits of this quantity through the study of a sum rule that limits its spectral integral, taking into account both its radiative and nonradiative components. The sum rule studied here establishes that the integral over the spectrum of the LDOS at a certain point must be equal to the field induced by a static dipole placed at that same location. We confirm the validity of this sum rule by performing rigorous numerical calculations for a variety of nanostructures, including nanospheres, nanodisks, and films, made of different metallic and dielectric materials, as well as graphene. Furthermore, we extend the sum rule to the cross density of photonic states (CDOS), a quantity that characterizes the spatial coherence of light in the presence of a nanostructure and determines, as well, the interaction between two dipole emitters located in its vicinity. Besides the fundamental interest of this result, it can also be used as a guide to select the most favorable nanostructure geometries and materials to achieve strong values of the LDOS and the CDOS over desired parts of the spectrum, thus helping to engineer strong decay rates and coupling enhancements near nanostructures.