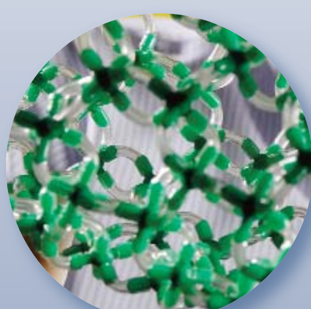
Georgia Tech

school of chemical & biomolecular engineering

Fourth Year Colloquium

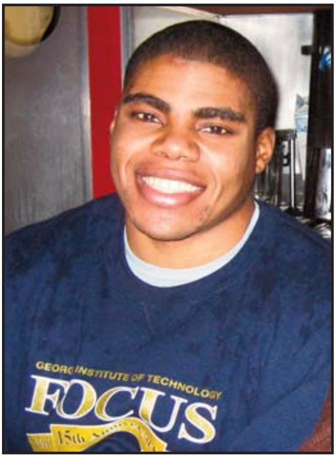
October 22, 2008



The 2009 Fourth Year Colloquium is Dedicated to the Memory of

Christopher Russell

1983 ~ 2008



Christopher J. Russell was born on December 7, 1983, at Verdugo Hills Hospital in southern California, and spent his early childhood in Orange, California. It was there that he attended a private elementary school and first realized his interest in science and math. During his pre-teen years he participated in National Junior Basketball, Junior All-American Football, and Cub Scouts.

At the age of 11, Chris moved to Irvine, California, where he attended middle school. At this time he continued to develop his love of science and was active in student government. He had a prosperous high school career, where he excelled in science and mathematics, and graduated among the top students in his class. Throughout these years he enjoyed attaining the rank of Eagle Scout, being a wrestler, track & field athlete, and captain of the football team.

After high school, Chris attended the Massachusetts Institute of Technology (MIT), where he majored in chemical engineering. During his time at MIT he discovered his passion for research. He participated in undergraduate research every semester after freshman year and completed four summer internships.

Upon graduation he began his tenure in the School of Chemical & Biomolecular Engineering at Georgia Tech, where he pursued his doctorate degree in chemical engineering. He won two prestigious fellowships at Georgia Tech – the FACES Fellowship and the IBM Focus Fellowship. He made commendable progress in his research project and was preparing to present his latest results at the AIChE Annual Meeting in November 2008. He was selected for the 2008 Dow Chemical Company BEST Symposium, which brings together outstanding doctoral students from all over the country to discuss career opportunities at Dow.

Before his unexpected passing, Chris was scheduled to present on his successful research progress at the ChBE Fourth Year Colloquium. In memory of his bright spirit and his fine qualities as a student, researcher, and friend, the School has dedicated the 2008 Fourth Year Colloquium to his lasting memory.

Step-Scan Photoacoustic Spectroscopy Techniques for the Direct Measurement of Intra-Membrane Adsorption and Transport Phenomena

Presenter: Christopher Russell / Advisor: Sankar Nair

Selectively permeable inorganic membranes have attracted great interest for chemical separations, energy conversion, and environmental remediation. However, the structural complexity of these membranes often leads to ambiguity in interpretation of experimental transport data. The objective of this work is to develop and validate the application of Step-Scan PhotoAcoustic Spectroscopy (SS-PAS) as a non-destructive, in situ technique for direct measurement of intra-membrane transport and adsorption phenomena. Our photoacoustic spectral analysis method is demonstrated by the study of hydrocarbons (hexane and p-xylene) in zeolite membranes. We show how in situ steady-state permeation experiments and sorption measurements can be used to determine intra-membrane concentration profiles.

The 2008 Fourth Year Colloquium
is sponsored by
The Dow Chemical Company

Fourth Year Colloquium

Wednesday, October 22, 2008

The School of Chemical & Biomolecular Engineering and AChEGS present the second annual Fourth Year Colloquium.

The event is held to showcase the research accomplishments of Ph.D. graduate students who are entering their fourth year in the program.

Schedule

4:00–5:00 p.m.	"M" Bldg. ~ G011	Keynote Addresses *2008 Ziegler Award Winners*
5:00–5:30 p.m.	ES&T ~ First Floor Atrium	Snack Break
5:30–7:15 p.m.	ES&T ~ Various Locations *(See program for details)*	Presentations *Fourth year Ph.D. candidates*
7:15–8:30 p.m.	ES&T ~ L1 Atrium	Dinner

The Ziegler Awards

The Waldemar T. Ziegler Awards were established by the family and friends of the late Dr. Waldemar T. Ziegler to honor his lifelong commitment to academic excellence and to research. Dr. Ziegler was a member of the faculty of the School of Chemical Engineering at Georgia Tech from 1946 until his retirement in 1978, when he was named Regents' Professor emeritus. He died in 1996 leaving behind a legacy of outstanding research in the fields of cryogenics and thermodynamics. Dr. Ziegler was instrumental in establishing both the School's and Georgia Tech's reputation for outstanding research.

Currently, two individual Ziegler Awards are presented annually to graduate students. The Ziegler Award for Best Paper Authored by a Graduate Student was first awarded in 1998, and the Ziegler Award for Best Ph.D. Proposal was first awarded in 2005.

2008 Ziegler Award Winners

Best Paper Award

Jeong Woo Lee

Best Ph.D. Proposal

Balamurali Balu

Jeong Woo Lee

Advisor: Mark Prausnitz

Dissolving Microneedles for Transdermal Drug Delivery

Microfabrication technology has been adapted to produce micron-scale needles as a safer and painless alternative to hypodermic needle injection, especially for protein biotherapeutics and vaccines. This study presents a novel design that encapsulates sensitive biomolecules within microneedles that dissolve within the skin for bolus or sustained delivery and leave behind no biohazardous sharp medical waste. A novel fabrication process was developed based on casting a viscous aqueous solution during centrifugation to fill a micro-fabricated mold with biocompatible carboxymethylcellulose or amylopectin formulations. This process encapsulated sulforhodamine B, bovine serum albumin, and lysozyme as model drugs; lysozyme was shown to retain full enzymatic activity after encapsulation and to remain 96% active after storage for two months at room temperature. Microneedles were also shown to be strong enough to insert into human cadaver skin and then to dissolve within minutes. Bolus delivery was achieved by encapsulating model drug just within microneedle shafts. For the first time, sustained delivery over hours to days was achieved by encapsulating drug within the microneedle backing, which served as a controlled release drug reservoir that delivered drug by a combination of swelling the backing with interstitial fluid drawn out of the skin and drug diffusion into the skin via channels formed by dissolved microneedles. We conclude that dissolving microneedles can be designed to encapsulate sensitive biomolecules, insert into skin, and enable bolus or sustained release drug delivery.

Biography

Jeong Woo Lee was born in Ulsan, Korea. He earned his bachelor's degree at Korea University in 2001. He worked on the preparation of drug micro-particles using supercritical CO_2 processes at the National Research Lab of Supercritical Fluid Process, Korea Institute of Science and Technology from 2001 to 2003. Then, he joined the drug delivery lab of the School of Chemical & Biomolecular Engineering at Georgia Tech. He has been studying the physical methods to enhance transdermal drug delivery since fall 2003.

Balamurali Balu

Advisors: Dennis Hess & Victor Breedveld

Fabrication of Superhydrophobic Cellulose Surfaces with Tunable Adhesion to Water Drops via Plasma Processing

In 1805, Young proposed a relationship between the forces acting at an interface between a liquid and solid: "…for each combination of a solid and a fluid, there is an appropriate angle of contact between the surfaces of the fluid, exposed to the air, and to the solid…" However, most real substrates exhibit a variety of contact angles, depending on whether the liquid-air interface is advancing or receding on the solid surface, rather than a unique contact angle. The range of contact angles, usually defined as the difference between the maximum and minimum contact angles observed at the advancing and receding fronts of the liquid drop, is termed contact angle (CA) hysteresis. For classifying the interaction between substrates and liquids, it is critical to specify both the CA and CA hysteresis values. As will be shown in this presentation, even if a surface is superhydrophobic (according to the common definition of a static or advancing water CA > 150°), it can be strongly adhesive to water drops. Contact angle hysteresis most closely correlates with the magnitude of these adhesive forces and by tuning the hysteresis, the dynamics of drops on superhydrophobic surfaces can be controlled, making possible numerous new applications.

Superhydrophobicity has been achieved on cellulose surfaces by domain selective etching of amorphous portions of the cellulose, followed by coating of the surface structures generated with a fluorocarbon film deposited via plasma enhanced chemical vapor deposition (PECVD). The hysteresis of these superhydrophobic surfaces can be tuned between 149.8±5.8° and 3.5±1.1° through the controlled fabrication of nano-scale features on the cellulose fibers. This process takes advantage of the inherent nano-meter length scales of the amorphous and crystalline domains of cellulose fibers and the non-conformal film deposition property of PECVD process. Superhydrophobic cellulosic surfaces with tunable hysteresis (adhesion) provide control of aqueous drop mobility and thus of the transfer characteristics of water drops. Moreover, the fact that these substrates are based on cellulose fibers, a biodegradable, inexpensive, flexible, biopolymer, widens potential commercial opportunities for these materials.

Biography

Balamurali Balu was born in Kanchipuram, a suburb of Chennai, India in 1981. After schooling in St. Joseph's Higher Secondary School (Chengalpet) he attended Coimbatore Institute of Technology, where he obtained his B.Tech degree in Chemical engineering in 2002. After finishing his B.Tech degree he worked in Infosys Technologies (Bangalore) as a Software Engineer. He came to the US in 2003 to pursue a M.S. degree in Environmental Engineering at University of Wyoming. After finishing his M.S. degree, he joined the School of ChBE at Georgia Tech in 2005 to pursue his doctoral research specializing in surface modification of polymers via plasma processing, under the supervision of Dr. Dennis W. Hess and Dr. Victor Breedveld. He says his Ph.D. life can never be better and he extremely enjoys working in a unique combination of two different research groups pioneering in microelectronics and complex fluids, respectively. Apart from research he loves composing music and playing drums.

1: Advances in Biotechnology. . . . . Room L1255

Session Chair: Andres Hernandez Moreno **5:30-7:15 p.m.**

Ultrasound-mediated Gene Transfection

Presenter: Ying Liu / Advisor: Mark Prausnitz

Ultrasound is believed to transport DNA into cells through transient pores in cellmembrane, but only a fraction of cells with intracellular DNA have efficient transfection (i.e., transgene expression). We analyzed cells after ultrasound exposure using gene chip analysis and found processes involved with intracellular trafficking, cell cycle and cell death were important to transfection. Addition of drugs that regulate identified intracellular processes were found to increase transfection. Ultrasound was also found not to damage gene delivery vectors. We conclude ultrasound can be a safe and potentially efficient method for gene delivery based on a better understanding of its mechanisms.

Application of a Continuously-operated Enzyme Membrane Reactor in the Determination of the Operational Stability of an Enzyme Undergoing Reversible Denaturation

Presenter: Thomas Rogers / Advisor: Andreas Bommarius

The correlation of short-term biochemical measurements to the accurate prediction of the productivity of an enzyme has only recently been mentioned in the literature but never proven. Here, TEM-1 beta-lactamase, which undergoes reversible thermal deactivation, was subjected to a temperature-time gradient in an enzyme membrane reactor (EMR). Total turnover number was predicted by fitting conversion data to the Lumry-Eyring model. The EMR results were correlated to kinetic data and thermal deactivation data from isothermal experiments. Well below the melting temperature of the enzyme, it was demonstrated that the total turnover number is a function of the catalytic constant (kcat) and the observed deactivation rate (kD,obs), two quantities which are readily measured by experiment.

Automated and Integrated Micro System for High-throughput and High-resolution Imaging, Sorting, and Laser Ablation of C. Elegans

Presenter: Kwanghun Chung / Advisor: Hang Lu

Visual screens and laser ablation of cells are frequently applied to multi-cellular model organisms for biological research and drug discovery. Although widely used, these techniques have remained manual and low-throughput. In my thesis project, we have been developing microsystems for high-throughput, high-resolution microscopy, sorting, and laser ablation of genetic models. We demonstrated automated high-throughput sorting with micro-chips capable of local temperature control, self-regulated sample-loading, and automatic sample-positioning. A novel in situ temperature measurement method using Brownian motion of nanoparticles was developed to characterize the micro-chips. In the future, advanced multiplex microsystems will be developed for high-throughput laser ablation.

Evaluating Intermolecular Interactions in Protein Solutions by Light Scattering Techniques: Static and Dynamic Studies of Apoferritin Solutions

Presenter: Quinta Nwanosike / Advisors: Ronald Rousseau & Athanassios Sambanis

The second virial coefficient, B_{22}, has long been used as a measure of protein-protein interactions in solution. Static light scattering (SLS) is the most commonly used method for measuring B_{22}. However, SLS works best for stable protein solutions hence may not give accurate results for protein solutions in a dynamic state of aggregation where B_{22} is changing with time. It is proposed here that dynamic light scattering (DLS) works better than SLS for such systems. The results obtained in this study show that DLS alone may be used to derive B_{22}.

A Novel Reactive Oxygen Species Sensitive Delivery Vehicle for the Oral Delivery of siRNA

Presenter: D. Scott Wilson / Advisor: Niren Murthy (BME)

The overproduction of reactive oxygen species (ROS) is central to the development and persistence of inflammatory diseases such as inflammatory bowel disease (IBD). In this presentation, we introduce an ROS-sensitive microparticle formulated from a novel thioketal polymer that has the ability to encapsulate and ferry siRNA against TNF-α through the harsh environment of the gastrointestinal system then selectively release the encapsulated siRNA in the high ROS environment in and around inflamed gut mucosal tissue. IBD-mice receiving a daily oral dose of siRNA-loaded thioketal microparticles showed a lower level of disease development and a decreased level of TNF-α mRNA compared to untreated IBD-mice.

Cloning and Characterization of an α-Amino Ester Hydrolase from Xanthomonas campestris pv. campestris

Presenter: Janna Billy Blum / Advisor: Andreas Bommarius

The putative glutaryl 7-ACA acylase from Xanthomonas campestris pv. campestris (Xcc) strain ATCC 33913 is capable of the hydrolysis and synthesis of α-amino β-lactam antibiotics such as ampicllin. The gaa gene was cloned into the pET28 expression plasmid and expressed in Escherichia coli. A homology search indicates that this protein is 93% identical to the known α-amino ester hydrolases (AEH) from Xanthomonas citri strain IFO 3835 and 59% identical to the AEH from Acetobacter turbidans strain ATCC 9325, suggesting that the putative glutaryl 7-ACA acylase from Xcc strain ATCC 33913 belongs to the AEH subclass of enzymes. This protein has been characterized for both kinetic and thermodynamic properties. The results indicate that the putative glutaryl 7-ACA acylase is an AEH.

Suprachoroidal Drug Delivery to the Eye Using Microneedles

Presenter: Samirkumar Patel / Advisor: Mark Prausnitz

Current ocular drug delivery methods are either inefficient or invasive for treating diseases such as macular degeneration and diabetic retinopathy. Microneedles have the potential to provide a minimally invasive, targeted method of drug delivery to the back of the eye. We show for the first time that microneedles can deliver particle suspensions into the suprachoroidal space of rabbit, pig and human eyes. We also examine the parameters needed for successful delivery. The particles delivered into the suprachoroidal space can provide sustained delivery directly to the choroid and retina for diseases that affect the back of the eye.

2: Separations: From Design to Practice . . . . Room L1205

Session Chair: Manoj Agrawal **5:30-7:15 p.m.**

Crosslinkable Mixed Matrix Membranes for Natural Gas Separations

Presenter: Jason Ward / Advisor: William Koros

Gas separations utilizing membrane technology provide economic and environmental benefits over more conventional operations (e.g. cryogenic distillation and amine absorption). However, key challenges must be addressed before membranes can become a viable commercial option. Composite membranes – composed of molecular sieves dispersed throughout a polymer matrix – promise to transcend the efficiency/productivity tradeoff exhibited by pure polymer membranes, provided we can gain control of the sieve/polymer interface. Additionally, the use of crosslinkable polymer matrices can reduce the performance deteriorating effects of sorbent–induced plasticization. This talk will discuss strategies we believe will launch advanced membrane technology into commercial application.

One-Component, Switchable, Neutral to Ionic Liquid Solvents Derived from Siloxylated Amines

Presenter: Vittoria Blasucci / Advisors: Charles Eckert & Charles Liotta

We developed a new class of smart ionic liquids. Smart ionic liquids are those which undergo large step changes in properties when exposed to a stimulus (e.g. light or heat). The ability to change an ionic liquid's properties significantly is advantageous for chemical processes involving multiple steps (e.g. reactions, extractions, and/or separations) each of which requires different solvent characteristics. Smart ionic liquids will increase the utility of their earlier generations by incorporating facile separation. Specifically, we created one-component, thermally reversible, neutral to ionic liquid solvents derived from siloxylated amines and carbon dioxide. We apply these solvents to purifying crude oil.

Novel Chiral Separation Via Integration of Membrane Separation with Cooling Crystallization: DL-glutamic Acid Resolution

Presenter: Apichit Svang-Ariyaskul / Advisors: Ronald Rousseau & William Koros

Chiral separation of racemic mixtures is essential in the production of many pharmaceutical compounds, and the objective of here is to establish an alternative for existing chiral separation processes. Resolution of DL-glutamic acid is used as model system in testing the integration of membrane separation with cooling crystallization. The proposed process utilizes two crystallization chambers that are separated by a membrane that prevents transport of crystals from one chamber to the other. Experimental results were promising as the product purity was over 94%; the product yield was increased by up to 56% of the cooling crystallization process without the membrane.

Hydrothermal Synthesis of MgO Nanowhiskers on Zeolite Surfaces

Presenter: Pei Yoong Koh / Advisor: Amyn Teja

Sub- and near critical water were employed to synthesize and deposit MgO nanowhiskers on zeolite surfaces, starting with magnesium chloride and ammonia as reactants. The effect of temperature, pH, time, and reactant concentration on the size and morphology of the deposited MgO were investigated. Mechanisms of nanowhisker formation and deposition were postulated. The dispersal of MgO / zeolite particles in a polymer matrix was also studied and it was demonstrated that adhesion between zeolites and the polymer is greatly enhanced in the presence of MgO on the surface.

Membranes for Olefin Paraffin Separations

Presenter: Mita Das / Advisor: William Koros

Propylene is among the most important chemical feedstocks of the petrochemical industry and must be separated from petrochemical product streams. This research has primarily two goals. 1) Keep the efficiency (selectivity) high at higher pressure by suppressing plasticization. 2) Increase the selectivity and permeability with the use of mixed matrix membranes for commercial use. We have identified and successfully synthesized 6FDA-6FpDA polyimide for Propylene/Propane separation. We have been able to delay the plasticization occurrence by performing the experiment at 70°C and synthesizing very high molecular weight polymer. Currently we are working to create hybrid materials with enhanced permeability and selectivity.

3: System Analysis and Engineering . . . . Room L1118

Session Chair: Alison Stucky **5:30-7:15 p.m.**

Inference of Gene Regulatory Networks Using Multiple Types of Data

Presenter: Ugur Guner / Advisor: Jay Lee

Most biological functions arise from complex interactions between cell's numerous components, such as, DNA, RNAs and metabolites. A major challenge in biology is to map out and model the topological and dynamical properties of these networks. In this regard, this work aimed at introducing novel methods to reverse-engineer gene networks under reasonable assumptions which help to get around the complexity of the problem. Most importantly, the tools we will develop will be capable of fully integrating all different types of data in order to alleviate the poor information-to-unknowns ratio inherent to the problem. The second goal is to develop an optimal experimental design set up to infer the networks with the manipulation of experiments iteratively.

A Mathematical Programming Tool for the LCI Synthesis: A Case Study for the Carpet Production System

Presenter: Di Lu / Advisor: Matthew Realff

Chemicals are produced by a series of energy intensive transformations of feed stocks. The life cycle inventory (LCI) of mass and energy use in these supply chains is one measure of their overall environmental performance. We develop a methodology for examining life cycle choices available for a product and to optimize those choices based on criteria derived from their mass and energy usage. A method including a two-phase framework and a searching algorithm was developed to optimize polymer selections for a product based on LCI characteristics and to comprehend how processes can be designed to improve life cycle performance.

Improving Pharmaceutical Process Design: From Batch to Continuous Flow Reactor

Presenter: Michelle Kassner / Advisors: Charles Eckert & Charles Liotta

In industry, continuous flow systems are often preferable to batch processes due to enhanced reproducibility and scalability, improved yields, and better control over processing conditions. Low volume, high throughput continuous flow reactors are suited for reactions containing high exotherms and/or dangerous starting materials. Here we consider the challenges of converting a batch process to a continuous flow system to produce a pharmaceutical intermediate. Our reaction consumes diazomethane, a hazardous material, and produces a temperature-sensitive intermediate. We optimize the process by examining size scale, flow rate, concentration, and temperature. We also discuss the safety advantages of a continuous flow system.

Cellulosic Nanocomposites with Unique Morphology and Properties

Presenter: Jihoon Lee / Advisor: Yulin Deng

Nacre shows outstanding mechanical performances due to its unique and highly organized design. Synthetic pathways to artificial analogs of nacre have been developed. Layer by Layer (LbL) assembly with cellulose nanowhiskers is the nanoscale version of nacre. The structure and mechanical properties of cellulose nanowhiskers LbL assembly approached those of nacre. Ice-templated (IT) cellulose nanowhisker composites were also prepared by cryogenic processes which are simpler and easier than LbL approaches. Structural and functional resemblance between IT nanocomposites and nacres has been investigated.

Characterization of a Novel Methanol Solvate of Sodium Naproxen

Presenter: Krystle Chavez / Advisor: Ronald Rousseau

Solvents used in the production of crystalline pharmaceutical species can become incorporated into the lattice as solvates or hydrates (also known as pseudopolymorphs). These pseudopolymorphs have varying physical properties that can create difficulties in downstream processing and affect the safety and/or efficacy of a drug. Thus, knowing the existence of pseudopolymorphs aids in developing robust, large-scale processes industry. Sodium naproxen exhibits four pseudopolymorphs. These species have been characterized in literature, but a solvated, non-hydrated form of sodium naproxen has yet to be explored. In the present study, a solvated form was produced which has been characterized using various analytical techniques.

The Role of Solid and Liquid Phase Nonidealities in Determining the Solubility and Purity of Isomorphic Compounds

Presenter: Angel J. Olivera Toro / Advisor: Amyn Teja

The correlation and prediction of crystal solubility and purity in mixtures of hydrocarbons and amino acids is described, with emphasis on systems in which solid solution are formed . The crystal phase exhibits significant nonidealities even when the components are isomorphic or near-isomorphic compounds. Nonidealities in the liquid phase are also significant and are described using predictive UNIFAQ and COSMO-RS models. It is also shown that solute-solute interactions in the liquid phase play a significant role in these systems.

Microfluidic Systems to Create Complex Microenvironments in Cell-Based Assays

Presenter: Edward Park / Advisor: Hang Lu

The principal aim of this research is to develop microfluidic systems that enable the establishment and modulation of multiple, overlapping chemical concentration gradients in living cell-based assays. Such devices are uniquely capable of studying cell migration. Prototype devices have been validated quantitatively using fluorescent markers. In addition, experiments have been performed to demonstrate the ability to direct cell migration in well-controlled chemoattractant gradients. Also, the spatial activation of intracellular signaling molecules will be observed and correlated to gross behavior and external stimuli. Overall, this experimental platform could prove useful to expand our understanding of development, cancer, and other biological processes.

4: Electrochemical Device Fabrication & Implementation.......Room L1125

Session Chair: Jan Krajniak **5:30-7:15 p.m.**

Imprint Lithography and Characterization of Photosensitive Polymers for Advanced Microelectronics Packaging

Presenter: Venmathy Rajarathinam / Advisors: Sue Ann Bidstrup Allen & Paul Kohl

Imprint lithography has become an interesting research topic because of its potential to mass-fabricate nanometer scale integrated circuits. In this project, imprint technology will be applied to three microelectronics packaging applications: high aspect ratio chip to substrate interconnects, ultra-low loss coaxial interconnects on organic substrates, and high density lines and vias. In order for imprint lithography to contribute to interconnect technology, numerous scientific advances must take place. Imprint lithography requires conformal replication of stamp topography to generate patterns. Relationships between imprint material properties and imprint fidelity will be assessed with particular attention to thick film photo-imprint applications.

Challenges in Low-Temperature Fuel Cells

Presenter: Kevin Gallagher / Advisor: Thomas Fuller

We are investigating challenges related to durability and transport phenomena in the operation of low-temperature fuel cells. Here, we present our work on the durability of catalyst systems. The electrochemical oxidation of carbon catalyst supports reduces the activity of the cathode in both polymer electrolyte and phosphoric acid fuel cells. Investigations in the role of carbon microstructure, electrode history and reactant products are used to elucidate a kinetic mechanism.

All-Copper Chip-to-Substrate Interconnects

Presenter: Tyler Osborn / Advisor: Paul Kohl

A fabrication process has been developed and characterized to create all-copper chip-to-substrate input/output connections. Electroless copper plating followed by low-temperature annealing in a nitrogen environment was used to create an all-copper bond between copper pillars. The ability to fuse the two copper surfaces at modest temperature and pressure is demonstrated. During the anneal process, a significant microstructural transformation in the bonded copper–copper interface was observed. The changes were correlated to an increase in the bond strength. Successful silicon-on-silicon and silicon-on FR-4 bonding was achieved with no degradation of the organic board.

Hybrid System Designs to Mitigate Degradation of Electrochemical Devices

Presenter: Rajeswari Chandrasekaran / Advisor: Thomas Fuller

With increasing interest in energy storage and conversion devices for automobile applications, the necessity to understand and predict their life behavior is paramount. These electrochemical devices are most beneficial when used in hybrid configurations rather than as individual components. System models available in literature predict just the performance and do not include the durability and degradation issues associated with both fuel cells and batteries. The objective of this research is to capture degradation and durability issues in hybrid system model and to explore how changes in control strategies will mitigate the major degradation mechanisms.

Single and Multi-Component Molecular Photoresists

Presenter: Richard Lawson / Advisor: Cliff Henderson

As the minimum feature sizes in microelectronic integrated circuits (ICs) shrinks, the cost per transistor decreases while the computing power grows exponentially. Current minimum features in commercial ICs is 45 nm; to maintain the current rate of reduction in sizes, highly novel photoresists must be created that overcome limitations in current materials. Molecular photoresists are small molecules that have similar properties to polymers. We have designed, modeled, and synthesized several new classes of these materials that have superior properties to conventional designs of photoresists. These materials will be discussed and their properties and performance explained.