

North Carolina  
**NANO**  
Biotechnology  
CONFERENCE

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# Agenda

January 20, 2006 at the North Carolina Biotechnology Center

TIME	SESSION TITLES	SPEAKER NAMES	SPEAKER TITLES
8:30-9:15	Registration & Coffee		
9:15-9:30	"The Intersection of Biology and Nanotechnology: An Overview"	Gary Johnson, Department of Pharmacology at UNC-Chapel Hill	
9:30-10:15	"Highlights of Bionanotechnology at North Carolina State University"	Session Chair: Jerry lafrate	
		Dan Feldheim, Department of Chemistry	"Bio-nanomaterials for Energy"
		Nancy A. Monteiro-Riviere, Center for Chemical Toxicology Research and Pharmacokinetics	"Biological effects of nanomaterials in skin"
		Orlin Velev, Department of Chemistry and Biomolecular Engineering	"Assembly of bionanocomposite materials from live cells and functionalized particles"
10:15-11:00	"Nanobiotechnology at Wake Forest University"	Session Chair: David Carroll	
		G.L. Prasad, Division of Surgical Sciences-General Surgery	"Nanobiotechnology at Wake Forest University"
		David Carroll, Department of Physics	
		Michael Schmid, Department of Physics	
		Martin Guthold, Department of Physics	"Novel, Single-Molecule Methodology to Identify New Aptamers"
11:00-11:45	"An Overview of Nanobiotechnology at UNC-Chapel Hill"	Session Chair: Rudy Juliano	
		Rich Superfine, Department of Physics	"Understanding Biological Forces at the Cellular and Molecular Level"
		Joe DeSimone, Department of Chemistry	"Solvent Resistant, Chemically Robust Elastomeric Materials are needed for a host of advanced technologies"
		Muhammad Yousaf, Department of Chemistry	"Interfacing Surface Chemistry with Cell Biology"
11:45-1:00	Lunch & Posters	Reyad I. Sawafta QuarTek Corporation	"NanoAccelerator"

TIME	SESSION TITLES	SPEAKER NAMES	SPEAKER TITLES
1:00-1:45	"Nanobiology and Biotechnology Research Programs in NC-HBCUs	Session Chair: A. Karoui	
		B. Vlahovic, Department of Physics, North Carolina Central University	"New Generation of Nanotechnology Based Biochemical Sensors"
		H. Asemota, Head of Nanobiology Division, Shaw University	"Proposed Research Program for the Newly Established Nanoscience and Nanotechnology Research Center at Shaw University"
		Alexander Umantsev, Fayetteville State University	"Nanotechnology Research Program at Fayetteville State University"
		Lei Zhang, Winston Salem State University	"Study of brain cells by near-infrared Raman spectroscopy and Raman Scattering"
		A. Karoui, Head of Nano-Optoelectronic Division, NNRC, Shaw University	"Nanoscale optical methods for investigation of biomaterials"
1:45-2:30	"Nanobiotechnology at Duke University"	Session Chair: David Needham & Thom LaBean	
		Chris Dwyer, Department of Electrical & Computer Engineering	"The Unique advantages of DNA self-assembled fabrication over conventional photolithography enable profound changes in the way computer systems are engineered"
		Anne Lazarides, Department of Mechanical Engineering & Materials Science "Plasmonics, Photonics, & Bionano"	
		Dan Kenan, Department of Pathology	"Interfacial Biomaterials: Guiding Biology on Synthetic Surfaces"
		David Needham, Department of Mechanical Engineering & Materials Sciences	
		Thom LaBean, Department of Computer Science	"Nanobiotechnology at Duke University"
		Robert Clark, Department of Mechanical Engineering & Materials Sciences	
2:30-2:45	Coffee Break		

TIME	SESSION TITLES	SPEAKER NAMES	SPEAKER TITLES
2:45-3:30	"Emerging Nanobiotechnology at UNC Charlotte and Carolinas Medical Center Charlotte"	Session Chair: Kenneth Gonsalves	
		Kenneth E. Gonsalves, Department of Chemistry, UNC-Charlotte	"Emerging Bionanotechnology at UNC-Charlotte & Carolinas Medical Center"
		Craig Halberstadt, Director of Tissue Engineering, Carolinas Medical Center	
		Amy Ringwood, Department of Biology, UNC-Charlotte	"Oysters as valuable models for characterization on Nanoparticle risks in Aquatic Organisms"
3:30-4:00	"Nanobiotechnology at ECU"	Session Chair: Jim Gibson	
		Shaw Akula, Department of Microbiology And Immunology	"KSHV and the use of Raman Tweezers"
		James Gibson, Department of Pharmacology And Toxicology	"Toxicity"
		Fabrice Jotterand, Department of Medical Humanities	"Ethics"
		Timothy Johnson, Department of Medicine	"Therapeutic Medical Applications"
4:00-4:30	North Carolina's Nano Initiative	Robert McMahan, Senior Advisor to the Governor for Science and Technology; Executive Director, NC Board of Science and Technology	
4:30-5:00	Wrap-up		
5:00-6:00	Reception		



# Speaker Abstracts



## “Bio-nanomaterials For Energy”

**By Dan Feldheim, PhD**  
**North Carolina State University, Department of Chemistry**

Solid-state materials have played such a significant role in the development of humankind that we now mark the passage of time with such terms as Iron Age and Bronze Age. Today there is no shortage of materials needs, yet the landscape of possible solid-state inorganic compounds is almost incomprehensively vast. Considering all the possible combinations of the 30 transition metal elements alone yields over  $10^{30}$  different materials. How can we possibly hope to find the perfect combination of atoms for the materials so desperately needed for advanced fuel cell technology, hydrogen production, etc., if each composition is to be explored one-by-one or even using the best high-throughput screening methods available?

In nature materials discovery has taken the form of evolution and natural selection. Nearly every living organism on Earth has evolved mechanisms for forming solid-state materials, some for structural integrity or protection against predation, others for biosphere function such as light focusing or magnetotaxis. The hypothesis of the work to be presented is that the propensity of biomolecules to evolve in response to selection pressures can be harnessed in the lab to synthesize novel abiological materials. Indeed, it will be shown that RNA can evolve in vitro until sequences are found that catalyze the formation of materials with novel morphologies and physical properties. Applications of in vitro materials evolution toward the synthesis of new catalysts for applications in alternative energy will be discussed.

## “Biological Effects of Nanomaterials in Skin”

**By Nancy A. Monterio-Riviere, PhD**  
**North Carolina State University, Center for Chemical Toxicology Research and Pharmacokinetics**

Nanomaterials exhibit a variety of unique chemical and physical properties that have placed them in the forefront of emerging technologies, however, their effect on biological systems may result in similarly unique biological effects. Despite numerous potential societal benefits, there are limited toxicology studies that have addressed the effects of nanomaterials on a variety of organisms. Skin is a significant environmental and occupational exposure route for nanomaterials. There is no information available on the effects of multi-wall carbon nanotubes (MWCNT) on protein expression in human epidermal keratinocytes. Multi-wall carbon nanotubes (MWCNT), fullerene based amino acids and quantum dots will be discussed in respect to their interactions with human epidermal keratinocytes. The biological effects of these nanomaterials will be presented using transmission electron microscopy, atomic force microscopy, confocal microscopy, viability and cytokine assays. The interactions of nanomaterials in cultured human keratinocytes, absorption of nanomaterials through skin and confocal images depicting localization within skin will be presented. MWCNT were primarily localized in intracytoplasmic vacuoles, and induced the release of the proinflammatory cytokine interleukin 8 (IL-8) from keratinocytes in a time dependent manner. In addition, we have analyzed protein expression in human epidermal keratinocytes exposed to MWCNT previously shown to cause an inflammatory response by two-dimensional electrophoresis-based proteomic analysis. Altered expression of proteins were identified that suggests their involvement with vesicular trafficking and exocytosis, a finding consistent with the transmission electron microscopic changes described above. These data clearly show that MWCNT, not derivatized nor optimized for biological applications, are capable of intracellular localization within HEK and irritation in a target cell that composes a primary route of occupational exposure for manufactured nanotubes. We have also demonstrated that quantum dots of different sizes and surface chemistries are capable of penetrating into and being absorbed through skin. A thorough understanding of these basic exposure factors is needed before risk of this hazard can be determined in occupational or environmental scenarios. (Supported by USEPA-STAR Program #RD-83171501-0 and The National Academies Keck Futures Initiative).

## “Assembly of Bionanocomposite Materials from Live Cells and Functionalized Particles”

By Orlin D. Velev, PhD  
North Carolina State University, Department of Chemical and Biomolecular Engineering

New techniques of assembly of biosensors, nanostructures and nanodevices from live cells will be presented. They are based on principles for nanoparticle assembly into well defined 2D and 3D structures that we have developed earlier. We demonstrate how on-chip dielectrophoresis can be used to co-assemble yeast cells and synthetic micro- and nanoparticles. Depending on the frequency of the field and relative polarizability of the cells and particles, one and two dimensional arrays can be obtained. These arrays can be bound into permanent biocomposites by using molecular recognition. Such cell-nanoparticle chains and membranes can form the basis of sensors, microscopic bioreactors and artificial tissue. We also present a method for assembling and immobilizing large-scale coatings from yeast cells. The coating method is based on convective assembly and deposition in a moving meniscus to make dense two-dimensional arrays. A robust technique for rapid deposition of monolayer cell coatings was designed on the basis of this method. One immediate application of these structures is in biosensors and test beds for toxicity and drug action. The coassembly of live cells and synthetic nanoparticles also yields new biomaterials, in which the functionality of the cells is coupled to the functionality of the nanoparticles.

## “Nanobiotechnology at Wake Forest University”

By G.L. Prasad, PhD  
Wake Forest University, Division of Surgical Sciences-General Surgery

Nanotechnology holds immense promise and offers great potential in providing attractive solutions for many clinically significant problems. One of the concerns and limitations of applying nanotechnology and employing nanomaterials in biological systems relates to the potential hazardous effects of these compounds. Therefore, a better understanding of how nanoparticles interact with biological systems is essential to design and develop nanoparticles for biomedical applications. The focus of the present study is to evaluate the cytotoxic effects of fullerene ( $C_{60}$ ) particles.

Studies on the cytotoxic effects of  $C_{60}$  (prepared in ‘water soluble’ form) and its derivatives have yielded conflicting data. We have developed a new method of applying  $C_{60}$  from dried methanol suspensions, and investigated the effects on the growth of several normal and malignant cell types. This technique eliminates the use of harsher organic solvents, such as toluene and THF. We show that fullerene crystals are taken up by cells and that  $C_{60}$ , over a wide range of concentrations, does not inhibit cell growth. Further, we find that the reported toxic effects of  $C_{60}$  are either primarily due to the solvent or the modification of the nanoparticle following interaction with the solvents. Our results demonstrate that pristine fullerenes are not toxic to the growth and differentiation of cells, and are attractive for biomedical applications.

## “Novel, Single-molecule Methodology to Identify New Aptamers”

**By Martin Guthold, PhD**  
Wake Forest University, Department of Physics

Aptamers are short pieces of nucleic acid that fold up into a three-dimensional structure, enabling them to bind to molecular targets with high affinity. Several aptamers are currently in various stages of clinical trials. We are developing a novel, single-molecule methodology to select new aptamers from a pool of random oligonucleotides. Unlike SELEX, our approach does not require iterative cycles of selection and partitioning, but aptamers are selected one-by-one. At the core of our methodology is unique instrumentation that combines a nanoManipulator Atomic Force Microscope (nM-AFM) and an inverted optical microscope with TIRF illumination and FRET detection capabilities.

This instrument, in combination with PCR, is used to identify new aptamers as follows. Target molecules, potentially labeled with a donor fluorophore, are linked to a cover slip. A large library of random-sequence oligos, which are labeled with an (acceptor) fluorophore and a 100 nm bead (for AFM detection and pick-up), are then flowed over the target area. High-affinity, target-specific aptamers will bind tightly to the target for relatively prolonged periods resulting in a strong fluorescence signal. Background fluorescence is low due to TIRF illumination. The AFM is directed to the spot at which the fluorescence signal was observed, and the AFM tip is used as a “gripper” to retrieve the bead plus the attached aptamer. PCR is then used to amplify the extracted aptamer.

We have implemented the instrumentation and completed proof-of-principle experiments with a known thrombin aptamer. We successfully detected (AFM and fluorescence), extracted and amplified thrombin-aptamers from a pool of random oligonucleotides.

## “Understanding Biological Forces at the Cellular and Molecular Level”

**By Richard Superfine, PhD**  
The University of North Carolina at Chapel Hill, Department of Physics

Many processes in biomedicine require the quantification of forces and the response of biosystems to applied force. In our NIH funded center Computer Integrated Systems for Microscopy and Manipulation we are developing new techniques for measuring forces in biomedical settings ranging from DNA, molecular motors, cell division, blood clotting and cystic fibrosis. I will discuss the range of these techniques with particular attention to measurements on individual fibrin fibers that from blood clots and from our studies of mucus flow in human lung cell cultures.

## **“Solvent Resistant, Chemically Robust Elastomeric Materials are Needed for a Host of Advanced Technologies.”**

**By Joseph M. DeSimone, PhD  
The University of North Carolina at Chapel Hill,  
Department of Chemistry**

The discussion will focus on microfluidic devices made from perfluoropolyether (PFPE)-based elastomers which show remarkable resistance to organic solvents and as such open up entirely new uses for microfluidic devices. Specifically, this work has the potential to expand the field of microfluidics to many novel applications involving micro- and nano-chemistry platforms. In addition, we have shown the utility of PFPE-based materials to be used as molds in soft lithographic imprint techniques. The materials show ideal properties for imprinting and molding techniques to generate isolated objects that are uniform in size and dimensionality down to the sub 10-nm regime. Fluoropolymer molds derived from complex dual damascene structures have been created which can be used for metrology as well as for replication. A versatile “top-down” method, Particle Replication in Non-wetting Templates (PRINT), for the fabrication of particles having absolute control over size, shape and functionality will also be described. When a liquid precursor is confined between a non-wetting, flexible mold and a non-wetting substrate, particles having a designed shape and size can be formed. Fluoropolymer molding materials used in PRINT eliminate the formation of an interconnecting “scum layer” which plagues other soft lithographic techniques. Isolated, harvestable mono-disperse particles with a range of shapes can be fabricated down to the tens of nanometers size out of a wide range of materials, including the incorporation cargos useful for nanomedicine applications. The combination of the PRINT platform with well-developed printing and molding technologies, such as silk-screen printers and compression molding equipment, will allow for the creation of a “particle foundry” -- the functional equivalent of the continuous fabrication methodologies employed by the microelectronics industry -- for fabricating delicate organic particles necessary for use in nano-medicine and other emerging nanotechnologies.

## **“Developing New Surface Chemistries for Applications in Biotechnology and Cell Biology”**

**By Muhammad N. Yousaf, PhD.  
The University of North Carolina at Chapel Hill,  
Department of Chemistry**

Cells exist in highly dynamic evolving biological environments. I will discuss a surface chemistry strategy to develop dynamic model substrates to study cell behavior. A methodology to generate gradients on surfaces will also be presented to study cell adhesion and migration.

## “Nanoaccelerator”

**By Reyad I. Sawafta, PhD**  
**QuarTek Corporation, President & CEO**

NanoAccelerator is a business incubator for startup companies that own innovative technology in the field of Nanotechnology with significant commercial potential. We develop new companies by partnering technology entrepreneurs with business experts, technology experts and investors. We are technology focused, business oriented, and success driven. We eliminate the barriers and obstacles that exist for entrepreneurs and investors by minimizing risks and maximizing opportunities.

QuarTek Corporation will work with founders of partner companies to reduce expenditures; we will give partner companies access to all available resources such as available equipment, office and lab space, business, financial and legal advice. For the partner companies, a manageable capital burn rate occurs by controlling the capital-draining expenses of staff salaries and benefits, office rent and overhead. Capital is spent on the highest priorities to maximize success. These combined strategies form a system for startup support that is responsive, innovative, cost effective, and geared for success.

The following factors are considered in evaluating potential partner companies:

- Synergy with QuarTek Technology Platform
- Level of Intellectual Property Protection
- Application and Market Potential of Technology
- Risk and Potential Return on Investment

## “New Generation of Nanotechnology Based Biochemical Sensors”

**By B. Vlahovic, PhD.**  
**North Carolina Central University, Department of Physics**

Throughout the next decade novel sensor design concepts that exploit breakthroughs in nanotechnology and optoelectronics will be developed. Recently nanostructures, such as quantum dots and carbon nanotubes have attracted considerable attention from experimentalists due to their potentially advantageous and unique device applications. Those novel optoelectronic devices (various sources of a coherent light, optically controlled quantum logic gates, single-molecule transistors, spin valves, etc.) are based mainly on the fundamental properties of nanostructures, i.e. on their discrete energy spectrum originating from the electronic confinement in nanostructures. In semiconductor quantum dot heterostructures, for instance, the sharply discrete energy spectra of the electron and hole as well as the enhanced overlap and electron-hole spin dependence of their wave functions, result in sensitivity to external light polarization, much lower (compared to conventional systems) threshold current density, much higher temperature stability of a threshold current, higher material and differential gains, and enhanced nonlinear optical effects. These advantageous coherent optical properties of semiconductor heterostructures provide unique opportunities for using such systems as optical photodetectors and biosensors. Nanostructure based detection systems will exhibit desirable characteristics, namely high sensitivity to relevant signals, excellent temperature stability, low mass, low power consumption, compactness, vibration tolerance and ease and robustness of integration with instrumentation.

Theoretical and experimental work on semiconductor and carbon nanostructures at NCCU will be presented, including: calculation of electronic energy states as function of nanostructure shape, size, composition, residual stress and external magnetic field; and experimental formation of nanostructures by pulsed lasers and electron beams, ion implantation, and chemical synthesis. New concepts for highly selective and sensitive biochemical sensors which use recent advances in nanotechnology and optoelectronics research will also be discussed.

## “Proposed Research Program for the Newly Established Nanoscience and Nanotechnology Research Center at Shaw University”

By H. Asemota, PhD.  
Shaw University, Head of Nanobiology Division

Shaw University, the oldest historically black university in the south of USA, is in a mission to promote and enhance its academic excellence through a cutting-edge integrated Science approach, achievable through the establishment of a Nanoscience and Nanotechnology Research Center (NNRC) of Excellence on its main campus. Establishment of the NNRC is a multi-million dollar enterprise that will be implemented in phases with funds garnered principally through governmental, industrial, and commercial contracts and grants, and partnerships. The NNRC is comprised of four divisions: Nanobiology and Environment Research, Nano-Opto-electronic Materials and Devices Research, Computational Materials and Atomistic Engineering Research, and Nanotechnology and Nanoscience Education and Outreach. This massive program is expected to elevate the academic level of science and technology at Shaw University and greatly enhance the development of nanotechnology in an HBCU. The projected research should result in the design of customer nanotechnology applications,

The Nanobiology and Environment Division will focus heavily on Nanobiotechnological activities. The projected R&D biotechnology program will enhance science and technology applicable to food, security, health, and education issues. Proposed key areas include: Nanomedicine, especially metabolism of cell diseases - application of nanobiotechnology to the analyses of NSAIDs side effects in animal models of diabetes and trauma; and fabrication of DNA-based Biosensors for clinical diagnostics, environmental hazards and both biowarfare and chemical warfare agents. Details of research plans will be discussed.

## “Nanotechnology Research Program at Fayetteville State University”

By Alexander Umantsev, PhD.  
Fayetteville State University, Department of Physics

A few years ago our Research Group has started a Program in Nanotechnology, which is supported primarily by the US Army Research Office. The primary goal of the Program is to theoretically and experimentally study thermodynamic properties of different materials with dimensions at nanoscale: nanoparticles, nanowires, and nanofilms. They became materials of choice in electronics, pharmacology, and biotechnology.

One project deals with nanofilms and nanoparticles of solid solutions, which have properties very different from their bulk counterparts. For instance, Fe-Cu and Fe-Ag binary systems are virtually immiscible in the bulk; however, 70 nm nanoparticles of these materials were found to form supersaturated solid solutions. Other examples are giant magnetoresistance of magnetic films, enhanced mechanical properties of metallic alloys, resonant tunneling in thin superconducting films, and enhanced efficiency of nano-vesicles for drug-delivery applications. Our Group studies nanofilms and nanoparticles of solid solutions using new and previously tested theoretical and computer simulation methods.

The ultimate goal of the second project is the technological development of electronic carbon nanocircuits using focused ion beam (FIB) method of fabrication of carbon nanowires on diamond and other carbonaceous substrates. The physical principle underlying the FIB method is the phase transformation of carbonaceous materials exposed to ion irradiation at doses above the amorphization threshold. Using FIB it is possible to fabricate planar conductive nanostructures with an area resolution down to 5 nm. Preliminary results show that FIB-written carbon nanowires on diamond substrates possess novel electronic properties. On this project our Group collaborates with the Research Group at College of Staten Island of the City University of New York.

## “Study of Brain Cells by Near-infrared Raman Spectroscopy and Raman Scattering”

By Lei Zhang, PhD.  
Winston-Salem State University, Department of Chemistry

Early detection of cancer with less invasive diagnosis is still a great challenge in clinical oncology. However, recently, Raman spectroscopy with optical tweezers has been used for cancer diagnosis. We use Raman spectroscopy to detect spectral changes between Astrocytoma (brain cancer cell) and Astrocyte (“normal” brain cell). Raman spectra for both Astrocytoma and Astrocyte are analyzed and discussed.

## “Nanoscale Optical Methods for Biomaterials Characterization”

By A. Karoui, PhD.  
Shaw University, Department of Physics & Materials Science

The Nano-Optoelectronic Division within the Nanoscience and Nanotechnology Research Center (NNRC) at Shaw University is using techniques and methods suitable for investigating biomaterials. These are based on optical techniques that allow sub-micrometer and nano-scale resolution as compared to their conventional counterparts. The salient feature of such techniques is the fact that they are non-invasive for living species. We have developed in collaboration with North Carolina State University (NCSU) a Near field Scanning Optical Microscopy (NSOM) capable of detecting electronic properties and deformations in solid materials with 100nm resolution. The high spatial resolution allows a focused time dependent measurements, which give insights on the activity of bio-cells and their components. Therefore, NSOM is modified to get smaller optical apertures, in the range of 50nm, to allow a better time resolved ability. We also use high Resolution Synchrotron Fourier Transform IR spectroscopy at Lawrence Berkeley National Lab. (LBNL), to analyze thin film material composition through the detection of local vibration modes. We collaborate with Jobin Yvon Inc. on ellipsometry technique, and we use the state of art Spectroscopic Ellipsometer to detect molecular conformal changes at the interface of bio-materials and a solid substrate. Thin layers of a biomaterial and interfaces with substrate explored with high sensitivity Ellipsometer yielded new type of data. Examples will be shown and briefly discussed.

## **“The Unique Advantages of DNA Self-assembled Fabrication Over Conventional Photolithography Enable Profound Changes in the Way Computer Systems Are Engineered”**

**By Chris Dwyer, PhD  
The Duke University, Department of Electrical & Computer Engineering**

This research is focused on the vertical integration of engineered DNA self-assembled structures to implement advanced computer architectures and systems. Our strategy involves tight feedback between device, circuit, and architectural research with experimental effort in all areas. This talk will outline the basic research goals and recent progress made toward realizing DNA self-assembled computer systems.

## **“Plasmonics, Photonics, And Bionano”**

**By Anne Lazarides, PhD  
Duke University, Department of Mechanical Engineering & Materials Science**

Nanostructures are known to exhibit fascinating properties, both quantized and classical in nature. For example, a coulomb blockade to electron transfer can be observed in pairs of metal nanoparticles, while chains of nanoparticles can propagate light according to the laws of classical electrodynamics. Many of these properties are of both fundamental scientific interest and also offer promise of contributing to new nanoscale technology. Our goal is to understand how nanoscale structure controls the static and dynamic properties of bioinorganic materials and to use this knowledge to design nanostructures and materials with useful properties. We are developing theoretical methods that make it possible to predict properties of nanostructures from properties of the components and are pursuing experimental studies of nanoscale structure. We are interested as well in the forces that control nanostructure assembly and we work closely with groups that have pioneered new strategies for making novel nanostructures.

## “Interfacial Biomaterials: Guiding Biology on Synthetic Surfaces”

**By Dan Kenan, PhD  
Duke University, Department of Pathology**

Interfacial biomaterials represent a novel coating technology capable of directing biological processes at the interface between a biologic and a synthetic surface. The approach relies on screening combinatorial libraries to identify unique peptides that adhere to a synthetic target such as a plastic or metal, or to a biological target such as a protein or cell. Next, two or more adhesion peptides are synthetically coupled to create an interfacial biomaterial that mediates the interaction of the protein or cell with the synthetic material. Other interfacial biomaterials may be created by coupling known signaling molecules to peptides that bind synthetic materials. Mixtures of interfacial biomaterials may be applied to a surface to achieve a particular desired biological outcome, such as adhesion of a given cell type to the surface, followed by induction of one or more signal transduction pathways. These interfacial biomaterials are amenable to numerous coating and patterning techniques suggesting their use for diverse applications ranging from biomedical device coatings to meso- and nano-scale engineering to tissue engineering.

## “Nanobiotechnology at Duke University”

**By David Needham, PhD  
Duke University, Department of Mechanical Engineering & Materials Science**

Dr. Needham’s research program combines the fields of Materials Science with Colloid and Surface Chemistry focusing on “Biological and other Soft Wet Materials”. The program is in the general area of forming, coating and encapsulation of solid, liquid and gaseous particles in the colloidal size range (10 nanometers to 10 micrometers) and deals more specifically with the material properties of 2-phase micro and nanosystems, such as lipid monolayers, lipid bilayer membranes, hydrogels, wax particles, emulsions, microdroplets, gas bubbles, microcrystals, microglasses, polymer microspheres, and blood and cancer cells. It is also concerned with the adhesion and repulsion between particle surfaces involving molecular structures at interfaces including repulsive interactions due to the presence of grafted water-soluble polymers and specific interactions between receptors-ligand pairs. Information gained in this work is directed towards, for example, improved image contrast agents, drug delivery systems, and blood substitutes, that use lipids and polymers to create micro- and nano-capsules and monolayer coatings. These systems are being tested pre-clinically and now clinically with collaborators in the Duke Medical Center.

## “Nanobiotechnology at Duke University”

**By Thomas LaBean, PhD.**  
**Duke University, Department of Computer Science**

Research in LaBean’s group focuses primarily on the use of DNA as an engineering material for bottom-up nanofabrication and for biomolecular computing applications. We design, build, and study self-assembling DNA nanostructures for formation of specifically patterned micron-scale objects with nanometer scale feature resolution. We use these DNA structures to organize other materials such as proteins, metals, nanoparticles, and carbon nanotubes. Potential applications include the further miniaturization of electronics circuits and devices, programmable molecular robotics, biosensors, molecular photonics, implantable medical devices, and molecular therapeutics.

## “Emerging Bionanotechnology at UNC Charlotte & Carolinas Medical Center”

**By Kenneth E. Gonsalves and Craig Halberstadt, PhD.**  
**The University of North Carolina at Charlotte & Carolinas Medical Center**

The presentation will include a summary of ongoing projects:

- 1) Nano/microfabrication of novel polymers for tissue engineering applications (K. Gonsalves UNCC and Craig Halberstadt CMC)
- 2) Application of amphiphilic polymers for gene delivery (C. Yengo, K. Gonsalves UNCC and Qi Lu CMC)
- 3) Chemiluminescence photodynamic therapy via nanoparticle delivery systems (K. Gonsalves and W. Sisk UNCC)
- 4) Micro/Nanomachining of polymer surfaces for promoting osteoblast cell adhesion (K. Gonsalves and M. Hudson UNCC)
- 5) Characterization of quantum dots in aquatic organisms (A. Ringwood and K. Gonsalves UNCC).

An introduction to additional projects under development will also be included.

Educational features that lay the foundations for the successful implementation of bionanotechnology and nanomedicine at UNCC in collaboration with CMC will also be briefly discussed.

## “Oysters as Valuable Models for Characterization of Nanoparticle Risks in Aquatic Organisms”

**By Amy Ringwood, PhD**  
**The University of North Carolina at Charlotte,**  
**Department of Biology**

There are numerous potential environmental risks of engineered nanoparticles to aquatic organisms that are not yet well-characterized or understood. Nanoparticles may be introduced into aquatic environments during production processes and also as a result of release following their use in electronic and biological applications. We present here some preliminary results regarding the characterization of the behavior of quantum dots (QD) in seawater, and the accumulation of and toxicity to potential biological receptors, e.g. oysters, filter feeding bivalve mollusks. There are natural differences in environmental factors that may affect the degradation rates of QDs, including salinity and pH conditions, as well as seasonal differences in temperature. To determine the effects of salinity on degradation rates, nonfunctionalized QDs composed of a Cd/Se core surrounded by layers of Zn (Evident Technologies) were added to 0.22 filtered seawater samples of different salinities (10, 20, and 30 parts per thousand), and the changes in emission spectra over time were determined. The accumulation and potential toxicity of QDs were evaluated in oysters, *Crassostrea virginica*, particularly in isolated hepatopancreatic cells. Fluorescent confocal microscopy and electron microscopy were used to verify the accumulation of QDs, and toxicity to hepatopancreatic cells was determined using a lysosomal destabilization assay. These kinds of basic studies are essential for addressing the potential impacts of nanoengineered particles on aquatic organisms.

## “KSHV and the Use of Raman Tweezers”

**By Shaw Akula, PhD**  
**East Carolina University, Department of**  
**Microbiology & Immunology**

Diagnosis of a disease condition is most crucial for its treatment. Most importantly, it is crucial to detect a disease condition at its earliest possible stage to better direct a successful treatment. Kaposi's sarcoma-associated herpesvirus (KSHV), also referred to as human herpesvirus-8 (HHV-8) is etiologically associated with Kaposi's sarcoma, multicentric Castlemann disease, and primary effusion lymphoma. Raman spectrum profiles were generated to differentiate the uninfected from KSHV infected cells. In general, profiles from all the hematopoietic cells shared similar peaks; however, the relative abundance of specific components varied significantly between the cells. Subsequent use of the multivariate analysis of the Raman spectra revealed significant differences between the uninfected and the KSHV infected cells. This study reports the use of Raman tweezers to distinguish and analyze the biological relevance of KSHV infected-cell signaling. This is the first time near-infrared Raman spectroscopy has been used to analyze the physiological relevance of virus infection. Taken together, it is apparent that Raman tweezers can serve in the future as a diagnostic tool to detect infected and cancerous cells.

## “Is There a Risk of Adverse Effects from Exposure to Nanomaterials?”

By James Gibson, PhD  
East Carolina University, Department of  
Pharmacology & Toxicology

The nanotechnology industry has identified target enabling materials and technologies and have also recognized the essential need to understand the safety, health, and environmental impact as well as the need for establishing guidelines for exposure and safe handling for these various materials. Data, tools and protocols to characterize nanomaterials and their environmental and health effects are needed, including long-term and life cycle impacts. Several large and thoughtful analyses of the emerging technologies offered by nanomaterials have been published that address the social and economic challenges, the technical and political challenges and the barriers to commercial success. The common theme throughout was the potential health, safety and environmental impacts of nanotechnology are comparable to the impact of the existing chemical, electronics and biotechnology industries and the potential hazards should be judged in the same way. Our understanding is that current legislation should be sufficient to control the risks from nanoparticles, however, research into their potential toxicity should be funded, as it may differ from that of larger particles with respect to respiratory and genetic damage. Very little work has been done in order to ascertain the possible effects of nanomaterials on living systems. One possibility is that proteins in the bloodstream will attach to the surface of nanoparticles, thus changing their shape and function, and triggering dangerous unintended consequences. Finally, the ILSI Health and Environmental Sciences Institute has identified the topic “Analytical Detection, Environmental Fate and Toxicity of Nanoparticles” as an emerging issue of sufficient importance that a committee has been formed and a workshop is being planned to review the current knowledge and plan research programs to fill knowledge gaps.

## “Ethics of Nanotechnology: Towards an Integrated Model”

By Fabrice Jotterand, PhD  
East Carolina University, Department of  
Medical Humanities

Nanotechnology represents in part a technological revolution in the sense that it allows highly innovative applications to take place in various areas of the physical and life sciences. The development of nanotechnology and nanoscience, however, challenges the traditional understanding of how to pursue scientific and technological knowledge. Science (in its broad meaning) cannot any longer be construed simply as the quest for truth (pure science). Science becomes the source of economic (through technology) and, by extension, political power (i.e., politicization of science and technology).

In my presentation, I argue that nanotechnology is a good exemplar of “this politicization”, that is, the convergence of science, technology, politics, and economics for social and governmental purposes. At the same time, this new scientific ethos offers the possibility to integrate ethical and philosophical reflections at the core of the development of science and technology.

First, I look at how this politicization of science and technology has transformed science. Building on the work of John Ziman, I examine how the culture and the epistemic structure of scientific research and development have entered a new era of “post-academic science”. In particular, I show why each of the characteristics of post-academic science (i.e., a form of trans-disciplinarity, the marketability of knowledge and the norm of utility) represents a key component of the makeup of science and technology, which demands their integration in the overall structure of scientific development. This new scientific culture is highly trans-disciplinary and ties the production of scientific knowledge to two key elements: the first is the economic incentive in which the aims of scientific and technological development are not the production of knowledge per se but economic development and political hegemony. The second element is what Ziman characterizes as the norm of utility. This norm is closely related to economic considerations since within the new scientific culture new discoveries are assessed in term of their economic potentials, i.e., applications.

The second part examines the concept of utility within the new ethos of post-academic science, particularly

in relation to nanotechnology and argue that utility is a moral concept and consequently the new culture of contemporary science must enlarge its epistemological horizon and include moral considerations related to the human good and ends. This is not to suggest that a new ethics per se (“nanoethics” as a new moral theory) is necessary or that the integration of moral considerations has not occurred previously in reflections concerning science and technology. The tools provided by moral theory, bioethics, and medical ethics constitute a useful basis to guide our reflections. However, the particular context in which the development of nanotechnology occurs (i.e., post-academic science) offers the possibility to develop a model that emphasizes a better integration of ethical reflections in scientific and technological endeavors.

In the final part, I address the issue of how moral and philosophical considerations within the process of scientific research constitute a major shift in scientific inquiry. I argue that a new type of approach ought to be developed. In order to avoid simply reducing the ethic of nanotechnology to the ethic of physics, chemistry, biology or engineering and to integrate the various “ethics” intrinsic to these fields into the project of nanotechnology/nanobiotechnology, it is essential to develop a “procedural integrated ethics” (i.e., convergence of the scientific and the humanities cultures). In short, the transition from an academic to a post-academic science is not only the opportunity to (re)introduce a philosophical input into the development of science qua nanotechnology but likewise shows the necessity to develop a specific approach for nanotechnology and nanobiotechnology.

## “Engineered Nanoparticles for Targeted Delivery of NO to Decrease Ischemia/reperfusion in Injury in the Heart”

By Timothy Johnson, PhD  
East Carolina University, Department of Medicine

Timothy A. Johnson, PhD<sup>1</sup>, Wayne E. Cascio, MD<sup>1</sup>, John J. Lemasters, MD, PhD<sup>2</sup>, Mark H. Schoenfisch, PhD<sup>3</sup>, Nathan Stasko, BS<sup>3</sup>, Ekhsan L. Holmuamedov, PhD<sup>3</sup>

<sup>1</sup> East Carolina University, Greenville, NC, <sup>2</sup>Medical College of South Carolina, Charleston, SC,

<sup>3</sup>University of North Carolina, Chapel Hill, NC

The purpose of our studies is to develop the chemistry to sequester NO donors into chemically stable carriers (e.g., dendrimers) that can be directed to the myocardium in order to minimize ischemia/reperfusion (I/R) injury. The advantages of dendrimers over conventional NO donors include the ability to: 1) vary the magnitude of NO release over a wide range based upon nanoparticle size and composition, 2) synchronize the NO release and duration with the reperfusion process through modifications to the NO donor and dendrimer exterior, and 3) target nanoparticles to myocardial tissue via ligand-receptor binding.

Our studies are designed to:

- synthesize several classes of dendritic nanoparticles that release NO via diazeniumdiolate NO-donor chemistry,
- prepare multifunctionalized dendrimers for the delivery of NO that contain modifications to increase biocompatibility, facilitate molecular imaging, and confer ligand-receptor targeted drug delivery,
- evaluate cytotoxicity, cellular uptake, and cytoprotection of dendrimer conjugates in cultured human umbilical vein endothelial cells (HUVEC), and
- demonstrate the localization of NO-releasing nanoparticles in myocardium in a porcine model of regional I/R and show that retained particles release NO and decrease I/R injury.

In so doing, we will develop a novel nanoparticle strategy to introduce the cytoprotective agent, nitric oxide, to salvage myocardium after clinically relevant periods of regional ischemia. Those strategies, in

turn, can be translated clinically for both primary and facilitated percutaneous coronary intervention angioplasty following acute ischemic heart disease. Moreover, since the nanoparticles are engineered to bind generally to vascular endothelium, other tissues (i.e., brain, kidney, and intestine) potentially may be selectively targeted for similar protection strategies.

# Speaker Bios



**H. Asemota, PhD**  
**Shaw University, Head of Nanobiology**  
**Division**

Professor Helen Nosakhare Asemota is currently at Shaw University in Raleigh North Carolina, USA as Professor of Biochemistry and Molecular Biotechnology, and Head of the Nanobiology and Environment Division of the newly-initiated Nanoscience and Nanotechnology Research Center of Excellence (NNRC). She is also Professor of Biochemistry and Molecular Biology at the University of the West Indies (UWI), Mona Campus in Jamaica. Professor Asemota holds a PhD. in Biochemistry, with over twenty five years collective experience of dedicated lecturing and research in different countries.

Prof. Asemota has served the European Union as Technical Assistant, the United Nations' Food and Agriculture Organization as Technical Cooperation among Developing Countries (TCDC) Consultant (2001-2002) and currently as International Consultant for Biotechnology (2003 to date). She has over the years promoted greater interdisciplinary and intercultural interactions. She is experienced in organizing national and international biotechnology training workshops. Many of her projects have involved technology transfer to farmers at grassroots level. She has also served as Visiting Research Professor/Fellow to many universities in Europe and the United States. She is experienced in leading large research teams at the national level (the UWI Yam Project in Jamaica), binational level (the Jamaica-Mexico Binational Technical Cooperation Project on Antinutritional Factors, which is coordinated from her laboratory), and at the international level (the UN-FAO Disease-free seed potato production programs, first in Syria, and now in Tajikistan - where she serves as the Chief Technical Advisor to a team of 26 National top scientists engaged in the country's disease-free seed potato production program). She is an awardee of the German Academic Exchange Fellowship (1988-1989) and Inter-American Development Bank (IDB)/UWI training grant (1994), and recently (2005) the United States Fulbright Grant, among others. Prof. Asemota has over 160 Publications, made up of over 60 full-length Refereed peer-reviewed articles in International Journals, 23 Technical Reports to International Organizations, Conference papers, Published Abstracts, Newspaper and Newsletter articles, in various aspects of applied Biochemistry, Biotechnology and Molecular Biology. Professor Asemota is well-grounded in training students for Research. She has graduated 10 PhDs, 7 MPhil, and over 40 B.Sc. research projects. Two patents have resulted from Prof. Asemota's work on yams to date. She is presently serving at Shaw University as the Head of the Nanobiology and Environment Division of the Nanoscience and Nanotechnology Research

Center (NNRC) of Excellence, where her focus is on "Application of Nanotechnology in Biological Systems for Sustainable development". She is happily married with four children.

**Shaw Akula, PhD**  
**East Carolina University, Department of**  
**Microbiology & Immunology**

Shaw M. Akula is an Assistant Professor at the Brody School of Medicine at East Carolina University, Greenville, NC. He joined the Department of Microbiology & Immunology in the year 2003. He leads a team of young graduate students in pursuit of understanding the pathogenesis initiated by Kaposi's sarcoma-associated herpesvirus (KSHV/HHV-8). His research primarily focuses on the role of oncoprotein Raf in KSHV mediated pathogenesis, including virus entry process, reactivation of KSHV latency, and tumorigenesis. In addition, his lab also focuses on the use of Raman tweezers to study different stages of KSHV infection. In fact, his lab was the first to analyze virus (of any kind) infection using Raman tweezers. He has published several peer-reviewed scientific articles.

**Joseph DeSimone, PhD.**  
**The University of North Carolina at Chapel Hill,**  
**Department of Chemistry**

Joseph DeSimone, Ph.D., William R. Kenan Jr. Distinguished Professor of chemistry at the University of North Carolina at Chapel Hill (UNC-CH) and professor of chemical engineering at North Carolina State University, is a leading researcher in material science, especially as it pertains to the translation of breakthroughs in the basic sciences into practical applications. DeSimone has published nearly 200 peer-reviewed scientific articles and has almost 100 patents in his name. In 2005 DeSimone was elected into the National Academy of Engineering and the American Academy of Arts and Sciences. In 1999, DeSimone became director of the \$40 million National Science Foundation Science and Technology Center for Environmentally Responsible Solvents and Processes. Dr. DeSimone's pioneering efforts have won recognition from many: The New York Times has called him "a Wunderkind of chemical engineering." In 1995, the Discover Magazine Innovator Award program recognized his work with CO<sub>2</sub>. Other accolades include the Presidential Green Chemistry Challenge Award and a 1998 R&D 100 Award for one of the most technologically significant products of the year. In 2000 DeSimone received the Oliver Max Garner Award from the University of North Carolina, given to that person, who in the opinion of the Board

of Governors' Committee, "... during the current scholastic year, has made the greatest contribution to the welfare of the human race." DeSimone received the 2001 Ernst and Young Entrepreneur of the Year Award for Technology in the Carolinas, the 2002 Carothers Award from the Delaware Section of the ACS, and the 2002 Engineering Excellence Award from DuPont. DeSimone was recently selected to receive the 2002 John Scott Award by City Trusts of Philadelphia which is given to "the most deserving men and women whose inventions have contributed in some outstanding way to the comfort, welfare and happiness of mankind." In 2005, DeSimone was the recipient of the ACS Award for Creative Invention.

**Chris Dwyer, PhD**  
**Duke University, Department of Electrical & Computer Engineering**

Chris Dwyer received his B.S. in computer engineering from the Pennsylvania State University in 1998, and his M.S. and Ph.D. in computer science from the University of North Carolina at Chapel Hill in 2000 and 2003, respectively. He worked in the Department of Physics & Astronomy at UNC as a Postdoctoral Fellow and at the Department of Computer Science at Duke as a Visiting Assistant Professor from 2003-2004. Dwyer has been an assistant professor in the Department of Electrical and Computer Engineering and the Department of Computer Science at Duke University since July of 2004.

**Dan Feldheim, PhD**  
**North Carolina State University, Department of Chemistry**

Dan Feldheim is currently Professor of Chemistry and Associate Member of Biomedical Engineering at North Carolina State University. He joined the faculty of NC State University in 1997 after completing his PhD work in analytical chemistry with Professor Mike Elliott at Colorado State University in 1995 and a NSF Postdoctoral Fellowship in Professor Thomas E. Mallouk's lab at Pennsylvania State University. He is the recipient of awards from The Society of Electroanalytical Chemists, The Arnold and Mabel Beckman Foundation, and The David and Lucile Packard Foundation. His research is focused on the evolution of biomolecule catalysts for the production and utilization of alternative fuels such as hydrogen.

**James Gibson, PhD**  
**East Carolina University, Department of Pharmacology & Toxicology**

James E. Gibson, Ph.D. is Research Professor of Pharmacology and Toxicology at The Brody School of Medicine at East Carolina University in Greenville, NC and Fellow, Academy of Toxicological Sciences.

Previously, Dr. Gibson was Global Leader, for the Health, Environmental Sciences and Regulatory Functions for Dow AgroSciences. From 1976-1989 Gibson was Vice President and Director of Research for the Chemical Industry Institute of Toxicology.

He started his career in 1969 at Michigan State University where he was a professor in the Department of Pharmacology through 1976 and a visiting professor at the Pharmakologisches Institut, der Universität Mainz in Mainz, Germany in 1975 and 1976. Dr. Gibson received his Ph.D. in Pharmacology from the University of Iowa and completed the Executive Program in the Graduate School of Business Administration at the University of North Carolina at Chapel Hill.

He is a recipient of the Alexander von Humboldt Senior U.S. Scientist Award and the Society of Toxicology Achievement Award. He has served as president of the Society of Toxicology, associate editor, Toxicology and Applied Pharmacology, secretary-general of the International Union of Toxicology, president of the North Carolina Society of Toxicology, member of the joint Science Advisory Board Review Panel for Endocrine Disruption Screening Committee, a member of the National Academy of Science review of dietary supplements and the editorial board for Archives of Toxicology, among others.

He has authored over 120 publications. Gibson's research interests are in developing and evaluating in vitro methods for the safety assessment and exposure assessment of products of biotechnology, nanotechnology, harmful algal blooms and dietary supplements.

**Kenneth E. Gonsalves, PhD**  
**The University of North Carolina at Charlotte, Department of Chemistry**

Kenneth E. Gonsalves is the Celanese Acetate Distinguished Professor in the Department of Chemistry at the University of North Carolina at Charlotte. He obtained his PhD in chemistry at the University of Massachusetts at Amherst in 84, followed by Postdoctoral at MIT. He was a professor in the

department of chemistry and chemical engineering at Stevens Inst. of Technology NJ, 1986-1990 and then at the University of Connecticut at Storrs from 1990 to 2000. He joined UNC Charlotte in Jan 2001. He was also a visiting professor on sabbatical at Harvard University 1997 with Prof Whiteside. His major research interests are: materials synthesis: organic polymer chemistry; nanostructured materials/composites; biomaterials; novel resists for nanolithography; nanofabrication and nanopatterning of biomaterials. He has over 200 publications and 6 patents.

**Martin Guthold, PhD**  
**Wake Forest University, Department of Physics**

Martin Guthold is an assistant professor in the Department of Physics at Wake Forest University in Winston-Salem, NC. He is also a member of the Comprehensive Cancer Center at Wake Forest University Baptist Medical Center. He holds a B.S in Physics (1989) from the University of Ulm, Germany. He earned his M.A. (1994) and Ph.D. (1997), both in Physics, from the University of Oregon, Eugene, where he used Atomic Force Microscopy and various biochemical methods to study the structure of DNA and protein-DNA complexes. He did his postdoctoral work at the University of North Carolina, Chapel Hill, where he headed biological research in the Center for Computer Integrated Systems for Microscopy and Manipulation (CISMM). His current research interests focus on two areas. He is using a combined atomic force and fluorescence microscope to study the mechanical properties of single biomolecules and fibers. In collaboration with NanoMedica, Inc., he is also using this instrument to develop a new method for high-throughput aptamer and drug discovery. He is the recipient of the 2005 Reid-Doyle prize for Excellence in teaching.

**Craig Halberstadt, PhD**  
**Carolinas Medical Center, Director of Tissue Engineering**

Craig Halberstadt, PhD. is Senior Research Scientist, & Director of Tissue Engineering at the Cannon Research Center of the Carolinas Medical Center, Charlotte, North Carolina. Dr. Halberstadt received a B.S. degree in microbiology, and both M.S. and Ph.D. degrees in bioengineering from the University of Michigan. Dr. Halberstadt joined Carolinas Medical Center in December of 1996 as Senior Research Scientist, Director of Tissue Engineering. Dr. Halberstadt's main interest is in cell transplantation and the in vivo reconstruction of new tissues. One primary focus is on cell transplantation

utilizing a co-culture of Sertoli cells (cells isolated from the testis that confers local immunoprotection) and pancreatic islets for the treatment of type I diabetes. In addition to this, Dr. Halberstadt is in charge of the Human Pancreatic Islet Isolation facility in conjunction with Dr. Paul Gores. Recently the group was successful in the isolation of human islets from a cadaver donor pancreas and the subsequent transplantation of these islets into a Type I diabetic patient for the treatment of the patients' diabetes. Other research projects have focused on cell biomaterial interactions and their use for tissue engineering applications. Specifically Dr. Halberstadt's group has developed strategies for transplanting pre-adipocytes with a biomaterial to create soft tissue analogues and in collaboration with Dr. Ken Gonsalves has examined the utility of micro- and nano-patterned structures on mammalian cell behavior.

**Rudy Juliano, PhD**  
**The University of North Carolina at Chapel Hill, Department of Pharmacology**

Rudy Juliano obtained his Ph.D. in Biophysics at the University of Rochester and then did postdoctoral work in Experimental Pathology at Roswell Park Memorial Institute. He has served on the faculty of the University of Toronto, the University of Texas Medical School at Houston, and the School of Medicine of the University of North Carolina. At Carolina he served as Chair of Pharmacology for 16 years and is now a Professor in that department. His research interests include cell adhesion proteins, signal transduction, drug delivery systems and the molecular therapeutics of cancer. He was involved in some of the earliest work using lipid nanoparticles (liposomes) as delivery agents for therapy of infectious diseases and cancer. He has served on numerous NIH study sections as well as the editorial boards of *Cancer Research*, *Pharmaceutical Research*, *Biochimica et Biophysica Acta*, *Journal of Drug Targeting*, *Oligonucleotides*, *Molecular Pharmacology*, *Advanced Drug Delivery Reviews* and the *Journal of Cell Biology*. He currently serves as the Principal Investigator on the new NCI-funded Carolina Center for Cancer Nanotechnology Excellence.

**Timothy Johnson, PhD**  
**East Carolina University, Department of Medicine**

Timothy A. Johnson holds a BS (1972) in education from Illinois State University, a MS (1976) in natural science from Chicago State and a PhD (1983) in biomedical engineering and mathematics from the University of North Carolina at Chapel Hill. At the present time, Dr.

Johnson is a Professor of Medicine in the Brody School of Medicine at East Carolina University in Greenville, NC, where he investigates sudden cardiac death, life threatening cardiac arrhythmias and ischemia/reperfusion injury.

**Fabrice Jotterand, PhD**  
**East Carolina University, Department of Medical Humanities**

Fabrice Jotterand joined the Department of Medical Humanities in 2005. He received his Ph.D. from Rice University. Prior to his appointment at the Brody School of Medicine, Dr. Jotterand was Senior Managing Editor of *The Journal of Medicine and Philosophy* and currently serves on the Editorial Advisory Board of the Journal and the Editorial Board of the newly created journal *Nanoethics: Ethics for Technologies that Converge at the Nanoscale*. He is also a member of the Advisory Board of The Nanoethics Group, located in Santa Barbara, California.

Dr. Jotterand teaches medical ethics to first and second year medical students and a course on research ethics to doctoral students. His research interests focus on the ethics of nanotechnology, nanotechnology and medicine, the impact of technology on the practice of medicine, research ethics, medical professionalism, and the philosophy of medicine.

**A. Karoui, PhD**  
**Shaw University, Head Nano-Optoelectronic Division, NNRC**

Dr. A. Karoui, Associate Professor at Shaw University, has a PhD in Physics and a PhD in Materials Science. He is the associate director of a newly established Nanoscience and Nanotechnology Research Center (NNRC). He has been working on a number of research projects among which, ultra-high purity semiconductors and insulators materials including diamond, Si, SiGe, ... He is focusing on developing and using new techniques based on Optical Nano-Probes for non-invasive analysis of bio-materials. Among his research areas, he has been working on physics of semiconductors, nanoscale and atomic defects, crystal growth and phase transforms, carbon nanotube based nano-sensors, and quantum photovoltaic devices. He uses finite element analysis, quantum mechanics, and molecular dynamics for his multi-scale modeling of nano-features and nano-devices. Dr. Karoui has been working with opto-electronic material industries and the SiWEDS industry consortium (an NSF sponsored University/Industry research center), and National Labs, such as LBNL and NREL. He has developed patents in silicon nanotechnology.

**Dan Kenan, PhD**  
**Duke University, Department of Pathology**

Dan is an assistant professor of Pathology at Duke University Medical Center and the Scientific Co-founder of Affinergy. Dan received his Ph.D. in Microbiology and Immunology at Duke. He later received his M.D. at Duke where he continued residency training in Pathology.

**Thom LaBean, PhD**  
**Duke University, Department of Computer Science**

Thomas H. LaBean earned his Ph.D. at the University of Pennsylvania in 1993. He studied the folding properties of arbitrary sequence proteins expressed by random, synthetic DNA libraries under the guidance of Professor Stuart A. Kauffman and Professor Tauseef R. Butt. He then moved to Duke University and studied protein design with Professors Jane S. and David C. Richardson, and then worked on DNA-based computation with Professor John H. Reif. He now studies self-assembling biomolecular nanostructures as an Associate Research Professor at Duke University.

**Anne Lazarides, PhD**  
**Duke University, Department of Mechanical Engineering & Materials Science**

Education: Ph. D. - Princeton University.

Experience: Mechanical Engineering and Materials Science Department, Pratt School of Engineering, Duke University; Institute for Nanotechnology, Northwestern University; Xerox Center for Research and Technology, Webster NY; Department of Pharmacology, Yale University; Computervision Corp., Electronic Systems Division, Bedford MA; Analytical Sciences Corp., Reading MA

**Nancy A. Monteiro-Riviere, PhD**  
**North Carolina State University, Center for Chemical Toxicology Research and Pharmacokinetics**

Nancy Ann Monteiro-Riviere, Ph.D. is a Professor of Investigative Dermatology and Toxicology in the Center for Chemical Toxicology Research and Pharmacokinetics, Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University (NCSU) in Raleigh NC. Dr. Monteiro-Riviere is also a Professor in the NCSU/UNC-CH Biomedical Engineering Faculty as well as being a Research Adjunct Professor in the Department of Dermatology, School of Medicine at

the University of North Carolina at Chapel Hill. She received her B.S. in Biology (cum laude) from Stonehill College in North Easton, MA and her M.S. and Ph.D. in Anatomy from Purdue University in West Lafayette, IN. She completed post-doctoral training in Experimental Pathology / Toxicology at the Chemical Industry Institute of Toxicology in Research Triangle Park, NC. She joined the faculty at NCSU in 1984. She is a member of Sigma Xi and Phi Zeta honor societies. Dr. Monteiro-Riviere is President of the Dermatotoxicology Specialty Section, and past-president of the In Vitro Specialty Section of the Society of Toxicology. She presently serves on the NIH Scientific Advisory Committee on Alternative Toxicological Methods (SACATM), USEPA Scientific Advisory Panel-Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), Health and Environmental Sciences Institute Nanomaterial Safety Committee, International Life Sciences Institute (ILSI) Risk Sciences Institute Nanomaterial Toxicity Screening Working Group, the Board of Publications of the National Society of Toxicology, Associate Editor for Nanomedicine: A Multidisciplinary Review and on the Editorial Boards of the Journal of Applied Toxicology, Journal of Toxicology-Cutaneous and Ocular, Toxicology In Vitro, and Toxicology Mechanisms and Methods. Dr. Monteiro-Riviere has published more than 155 publications, holds a US patent, and has been the recipient of 9.5 million dollars in extramural research support from various government and private sources. Her research interests relate to chemical absorption, drug delivery and mechanisms of chemical irritation to skin. Current research focuses on the impact of engineered nanomaterials on human health and the environment. This research begins to assess the nature of interaction between manufactured nanoparticles and the skin; including dermal absorption, cutaneous toxicity as well as the ability to distribute to the skin after systemic exposure. These studies will utilize iron oxide nanocrystals, cadmium selenide nanocrystals and carbon fullerene nanoparticles that are representative of the broad spectrum of nanoparticles presently being used by industry. At the conclusion of the research, the boundaries of a dermal risk assessment for manufactured nanoparticle exposure will be available.

**David Needham, PhD**  
**Duke University, Department of Mechanical Engineering & Materials Science**

David Needham earned his Ph.D. at the University of Nottingham in 1981 in the area of gas-solid catalysis, with Prof Dan D. Eley, FRS. He then moved to the University of Cambridge (UK), Physiological Laboratory, to work on molecular mechanisms of anaesthesia, with Prof. D. A. Haydon F.R.S. A second post doc in 1983

took him to the Department of Academic Pathology, University of British Columbia, via a NATO/SERC Postdoctoral Fellowship working on synthetic membrane physical chemistry and biophysics of membrane - membrane interactions, with Prof. E. Evans. In 1987 he moved to the Department of Mechanical Engineering and Material Science at Duke University, where he has been ever since rising to the rank of full professor in 1998. He teaches in the area of Biologically Inspired Materials and Material Systems, --Mapping Engineering onto Biology.

**G.L. Prasad, PhD**  
**Wake Forest University, Division of Surgical Sciences-General Surgery**

G. L. Prasad is an Associate Professor in the Department of General Surgery, Wake Forest University School of Medicine, Winston-Salem, NC. He received his Ph. D. from the Indian Institute of Science (1986) and did postdoctoral work at the University of Texas, Galveston, and National Cancer Institute, Bethesda, MD. He moved (1996) to the Fels Institute of Cancer Research, Temple University School of Medicine, Philadelphia as a Research Assistant Professor. He took up the position of Assistant Professor at the WFUSM in 2000. His main research interests include the role of cytoskeletal proteins in neoplastic transformation, and the development of multifunctional nanoparticles for biomedical applications.

**Amy Ringwood, PhD**  
**The University of North Carolina at Charlotte, Department of Biology**

Dr. Amy H. Ringwood recently joined the biology faculty at UNC-Charlotte. She received her PhD from the University of Hawaii, followed by post-doctoral fellowships at the Pacific Biomedical Research Center, University of Hawaii and the Duke University Integrated Toxicology Program (Duke University Marine Laboratory and Medical School). She then held a position as a research scientist at Marine Resources Research Institute, Charleston, SC, and was a member of the graduate faculty at College of Charleston, University of South Carolina, and Medical University of South Carolina. Her primary research has focused on Environmental Toxicology, particularly in the areas of metal and pollutant toxicology, and also toxic algae effects, in marine organisms. She therefore brings her expertise in toxicology to important issues regarding effects of nanoparticles in aquatic organisms.

**Rich Superfine, PhD**  
**The University of North Carolina at Chapel Hill,**  
**Department of Physics**

Richard Superfine, Bowman and Gordon Gray Professor of Physics and Astronomy at UNC-CH, received his B. S. in physics from Lehigh University before working at AT&T Bell Laboratories for three years. He studied nonlinear optics for Ph. D. thesis at University of California at Berkeley, followed by a postdoctoral fellowship at Lawrence Berkeley Laboratories. His research includes the study of nanoscale phenomena in nanotubes, molecular motors and lung defense. In the area of instrumentation development, his research includes the development and application of advanced microscopy manipulation techniques and systems to biophysical systems and nanotechnology. He is the principal investigator of the UNC NIH resource for the application of computer science in microscopy. One microscopy system, the nanoManipulator, has been commercialized and has won an R&D 100 award (2001). He has served on numerous review panels for the NIH, DOD, DOE and National Science Foundation. He has received the Macres Award from the Microbeam Analytical Society, the Hettelman Prize for excellence in scholarship from UNC-CH, and the Johnson Award for distinguished undergraduate teaching from UNC-CH.

**Alexander Umantsev, PhD**  
**Fayetteville State University, Department of**  
**Physics**

Dr. Umantsev received his BS in Physics from Moscow Institute for Physics and Technology and his Ph.D. from the National Lab for Metallurgy. He moved to the US in 1989 and worked at first as a Post Doctoral Fellow and then as a Research Associate at Northwestern University. Dr. Umantsev obtained a position of Associate Professor of Physics at Fayetteville State University in 2002. He combines his teaching responsibilities in the Department of Natural Sciences with active research in different areas of materials physics. One of the areas that attracted his special attention is Nanotechnology. The primary goal of this program is theoretical and experimental analysis of the thermodynamic properties of different materials with nanoscale dimensions: nanoparticles, nanowires, and nanofilms. These materials find applications in different areas of electronics, pharmacology, and biotechnology. Dr. Umantsev published more than 40 papers on different subjects of materials physics and received grants from different Federal agencies, including NSF and ARO.

**Orlin Velev, PhD**  
**North Carolina State University, Department**  
**of Chemistry & Biomolecular Engineering**

Education: Ph.D. in Physical Chemistry University of Sofia and Bulgarian Academy of Sciences 1996, M.Sc Department of Chemistry, University of Sofia 1989, Professional positions and experience: 2001 — Assistant Professor, Dept. of Chemical Engineering, North Carolina State University 1998- 2001, Research Assistant Professor, Dept. of Chemical Engineering, Univ. of Delaware 1996-1998 Postdoctoral Fellow, Dept. of Chemical Engineering, University of Delaware 1994-1995, Researcher, Nagayama Protein Array Project, Japanese Exploratory Research for Advanced Technology program, Tsukuba, Japan 1993-1994, Research and teaching fellow, Laboratory of Thermodynamics and Physico- Chemical Hydrodynamics (LTPH), University of Sofia, Bulgaria

Selected recent awards:

Sigma Xi Faculty Research Award (Sigma Xi NCSU Chapter, 2004), CAREER Award (National Science Foundation, 2003), Ralph E. Powe Junior Faculty Award (Oak Ridge Associated Universities, 2002), Camille and Henry Dreyfus New Faculty Award (2001)

Selected research publications (out of 73 total):

- J. R. Millman, K. H. Bhatt, B. G. Prevo and O. D. Velev, *Nature Mater.*, 4, 98 (2005). Anisotropic particle synthesis in dielectrophoretically controlled microdroplet reactors.
- K. H. Bhatt, S Grego and O. D. Velev, *Langmuir*, 21, 6603 (2005). An AC electrokinetic technique for collection and concentration of particles and cells on patterned electrodes.
- R. G. Alargova, K. H. Bhatt, V. N. Paunov and O. D. Velev, *Adv. Mater.* 16, 1653 (2004). Scalable synthesis of new class of polymer microrods by a liquid-liquid dispersion technique.
- K. H. Bhatt and O. D. Velev, *Langmuir*, 20, 467 (2004). Control and modeling of the dielectrophoretic assembly of on-chip nanoparticle wires.
- S. O. Lumsdon, E. W. Kaler and O. D. Velev, *Langmuir*, 20, 2108 (2004). Two-dimensional crystallization of microspheres by coplanar AC electric field.
- O. D. Velev, B. G. Prevo and K. H. Bhatt, *Nature*, 426, 515 (2003). On-chip manipulation of freely suspended droplets.

- O. D. Velev, "Assembly of Electrically Functional Microstructures from Colloidal Particles", chapter in "Colloids and Colloid Assemblies", F. Caruso, Ed., Wiley-VCH Publ. Weinheim, 2003, pp. 437-464.
- K. D. Hermanson, S. O. Lumsdon, J. P. Williams, E. W. Kaler and O. D. Velev, *Science* 294, 1082 (2001). Dielectrophoretic assembly of electrically functional microwires from nanoparticle suspensions.
- O. D. Velev, A. M. Lenhoff and E. W. Kaler, *Science* 287, 2240 (2000). A class of microstructured particles through colloidal crystallization.
- O. D. Velev, P. M. Tessier, A. M. Lenhoff and E. W. Kaler, *Nature* 401, 548 (1999). A class of porous metallic nanostructures.
- O. D. Velev and E. W. Kaler, *Langmuir* 15, 3693 (1999). In situ assembly of colloidal particles into miniaturized biosensors.

**B. Vlahovic, PhD**  
**North Carolina Central University, Department of Physics**

Dr. Branislav Vlahovic, professor and chair of the Department of Physics, joined North Carolina Central University in 1995. He received his doctorate in physics and material science from University of Zagreb, Croatia. For his innovative research and work with minority undergraduate students and his contributions to the science, education, and welfare of the human race in 2004 was recognized by Oliver Max Gardner Award. Vlahovic's research spans from nuclear low to high-energy physics, from theoretical calculations to more applied research in quantum dots and thin films depositions, amelioration of structure of amorphous silicon, as well as computational physics. In all these fields he has made achievements that will have lasting impact. The polarimeter for high-energy photons, designed and built by Vlahovic and his team is a breakthrough in the field of experimental nuclear and particle physics. It makes possible an entirely new class of experiments with high-energy linearly polarized photons. The polarimeter is based on the electron-positron pair production off nuclei detected by the micro-strip detectors. It attains high analyzing power which makes the measurement of polarization not only possible but also achievable in a short period. His and his team's work in computational physics resulted in the solution of a long standing problem in nuclear low energy physics, by successful calculations of proton deuteron breakup above the threshold with the inclusion of Coulomb force. In nanotechnology field Vlahovic's current research is in development of bio-sensors based on quantum confinement, development

of high efficiency photovoltaic cells made by quantum dots and multijunction thin films, and calculation of charge transport through multi layers thin films and nanostructures.

**Muhammad Yousaf, PhD**  
**The University of North Carolina at Chapel Hill, Department of Chemistry**

Muhammad N. Yousaf, Assistant Professor of Chemistry and the Carolina Center for Genome Science, at UNC-Chapel Hill, received his B.Sc. in Chemistry from York University (Canada). He received a M.Sc. at the University of Massachusetts where he studied the structural and kinetic properties of inorganic materials. He then went on to the University of Chicago for his Ph.D. where he developed tailored electroactive surfaces for studies of interfacial reactions applied to new small molecule and protein microarray technologies. He also generated novel model substrates for studies of cell adhesion and migration. Muhammad then changed fields and was a postdoctoral fellow at Harvard where he studied the cell biology and biochemistry of regulated proteolysis during cell cycle transitions. His current research effort is to develop new surface chemistries for applications in biotechnology and cell biology. Muhammad has several patents in the areas of surface chemistry and MALDI mass spectrometry. He has served on NIH and NSF review panels. He has received a Damon Runyon Postdoctoral Fellowship and a Burroughs Wellcome Interface Career Award.

**Lei Zhang, PhD**  
**Winston-Salem State University, Department of Chemistry**

Dr. Lei Zhang is currently an assistant professor of Physics in Winston Salem State University. Dr. Zhang received his B.S in Space Physics from University of Science and Technology of China in 1988. During 1994-2000 he obtained M.S in Physics, M.S in Mathematics and PhD in Applied Physics from Florida International University, Louisiana Tech University and the University of Texas at Arlington, respectively. And after his two years full-time working experience as researcher/Engineer in optics/Materials industrial he serviced as a visiting assistant professor of physics in Elizabeth City State University between 2002 and 2005. His research areas include Nonlinear-Optics/Crystalline Materials and applications, he also co-operated his research with East Carolina University on Bio-Physics research.



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