

Interdisciplinary Research and Education: A University's Quest to Unite for the Future of Nanotechnology

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Interdisciplinary Research Environment: Highlights

Interfacial Sciences

- John Conboy – protein adsorption, phase segregation in lipid membranes, and ion transport between immiscible liquids
- Joel Harris – spectroscopic methods for molecular structure and dynamics at interfaces
- Jennifer Shumaker-Parry – high-throughput sensing methods for molecular recognition between biomolecules
- Loren Reith and Florian Solzbacher – (i) thin film high temperature compatible metal semiconductor interfaces, reliability and failure modes; (ii) thin film biocompatible encapsulation for physiological and wet environments, reliability and interface based failure modes

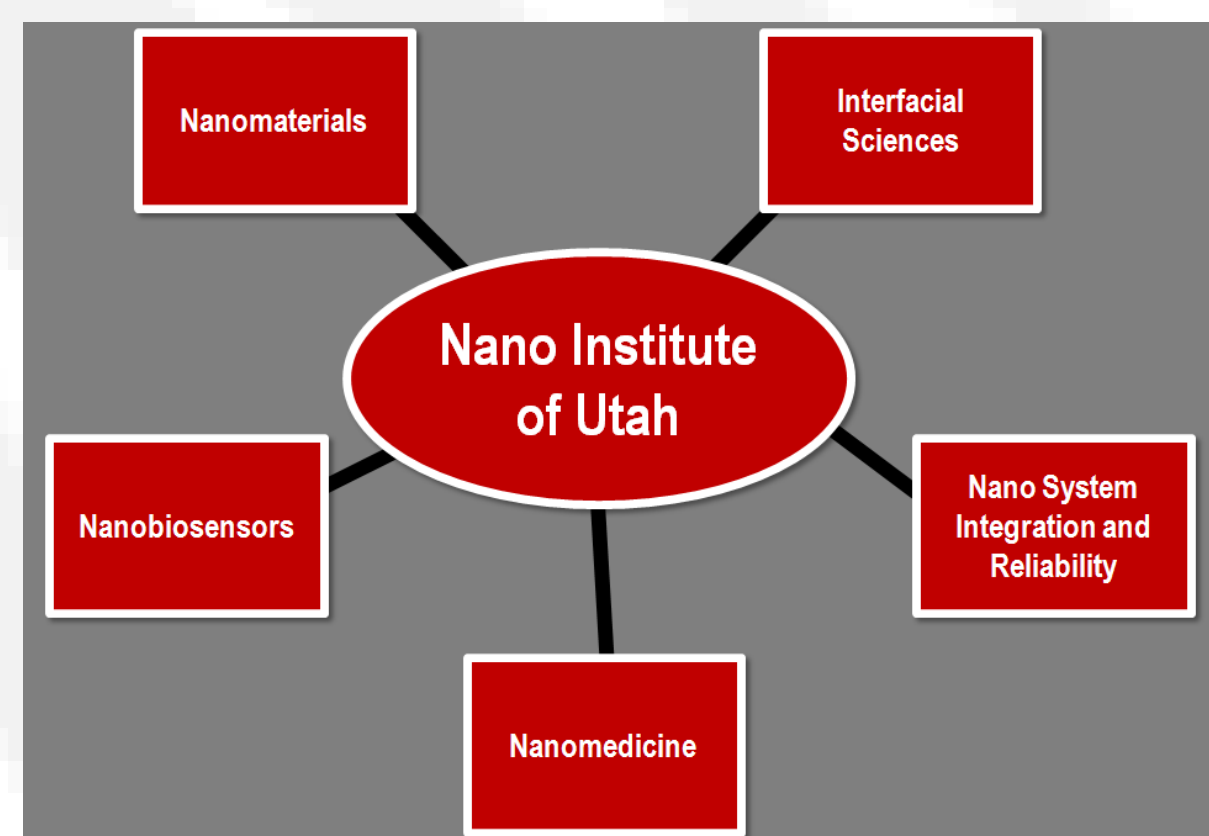
Nanomaterials

- Michael Bartl – control and manipulation of photons in optical integrated circuits and photonic chips
- Feng Liu – structural and mechanical properties of strained bi-layer nanoscale thin films
- Mark Miller – solid-state devices and materials engineered at the molecular scale
- Agnes Ostafin – functional nanoreactors that can be used for long-term tracking of biochemical markers of disease
- Ashutosh Tiwari – characterization of spin polarized light emitting diodes, and development of a laser-assisted plasma-based processing technique for creating superhard and tough nanocomposite coatings for harsh-environment applications
- Gerald B. Stringfellow and Michael Scarpulla – nano and quantum dot based optoelectronic materials and devices
- Anil Virkar and Florian Solzbacher – defect chemistry based electroceramic and metal oxide materials for gas and humidity sensing in harsh environments

Nanomedicine

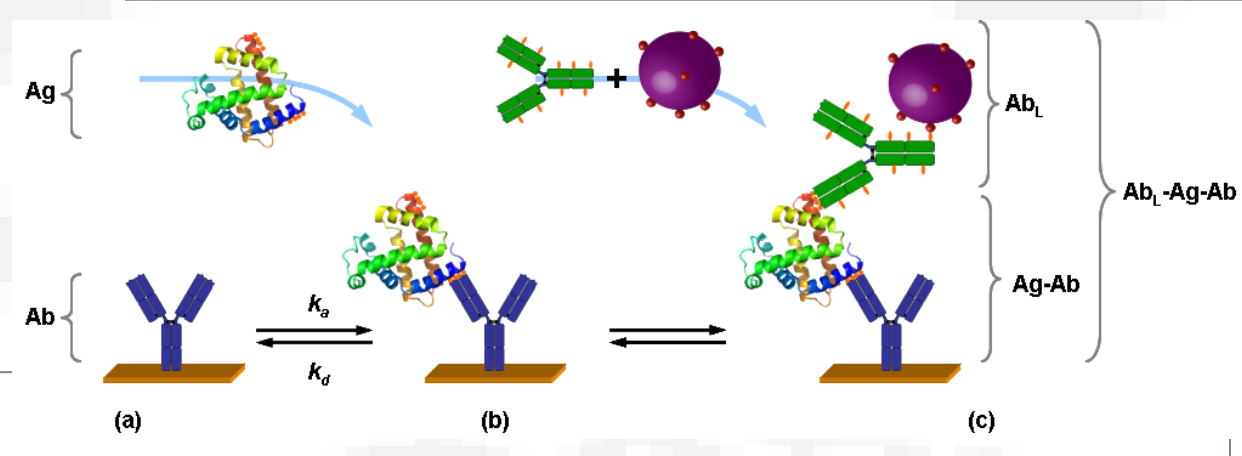
Nanomedicine

- You Han Bae – application of intelligent polymeric micelle systems in the 50 nm range to target cancer cells
- David Bull & Sun Wan Kim – polymer/DNA complexes for delivery of endothelial growth factor for neo-vascular formation and improvement of tissue function in ischemic myocardium
- Jindrich Kopecek – Design and development of polymer-drug conjugates for targeted treatment of cancer.
- David Grainger, Agnes Ostafin, John Veranth & Garold Yost – the effect of nanoparticle size and shape on cellular production of reactive oxygen species; and delivery of endogenous substances on nanoparticle surfaces and toxicity signals in cells
- Hamid Ghandehari – the influence of size, geometry, porosity and surface functionality of silica nanotubes, silica nanoparticles and dendrimers on toxicity, cellular uptake, biodistribution and pharmacokinetics
- Vladimir Hlady & Patrick Tresco – generating novel surfaces that resemble the native surface of nervous system cells to improve implant performance
- Dennis Parker – Evaluating magnetic resonance contrast agents to trace them in animal models as molecular imaging probes
- William Johnson – biological effects of nanomaterials for ecological monitoring studies under field conditions



Nanobiosensors

- Steve Blair – nucleic acid, protein, and cell-based microarrays for medical discovery and diagnostics
- Rich Brown – microlithography techniques to produce an array of microelectrodes allowing chemical detection on a scale near that of a single neuron
- Bruce Gale – nanoparticle analysis and separation using field flow fractionation
- Marc Porter – nanometrically engineered, biologically active surfaces to accelerate discovery and the screening of human and animal disease markers
- Mikhail Skliar – fringe-effect sensors for noninvasive measurements for the thickness of dielectric films
- Henry White – applications in biosensing, DNA sequencing and electrophysiology using a single conical-shaped nanopore embedded in a 50 nm glass membrane
- Florian Solzbacher, Richard A. Normann, Reid R. Harrison, Greg C. Clark, Bradley Greger, Paul House – neural interfaces for multi-channel single neuron recording and stimulation in neuroprosthetic applications and neurological disorders (epilepsy, etc.).
- Florian Solzbacher, Jules Magda: hydrogel based implantable sensors and systems for metabolic monitoring, diabetes, obesity, chronic infections, etc.

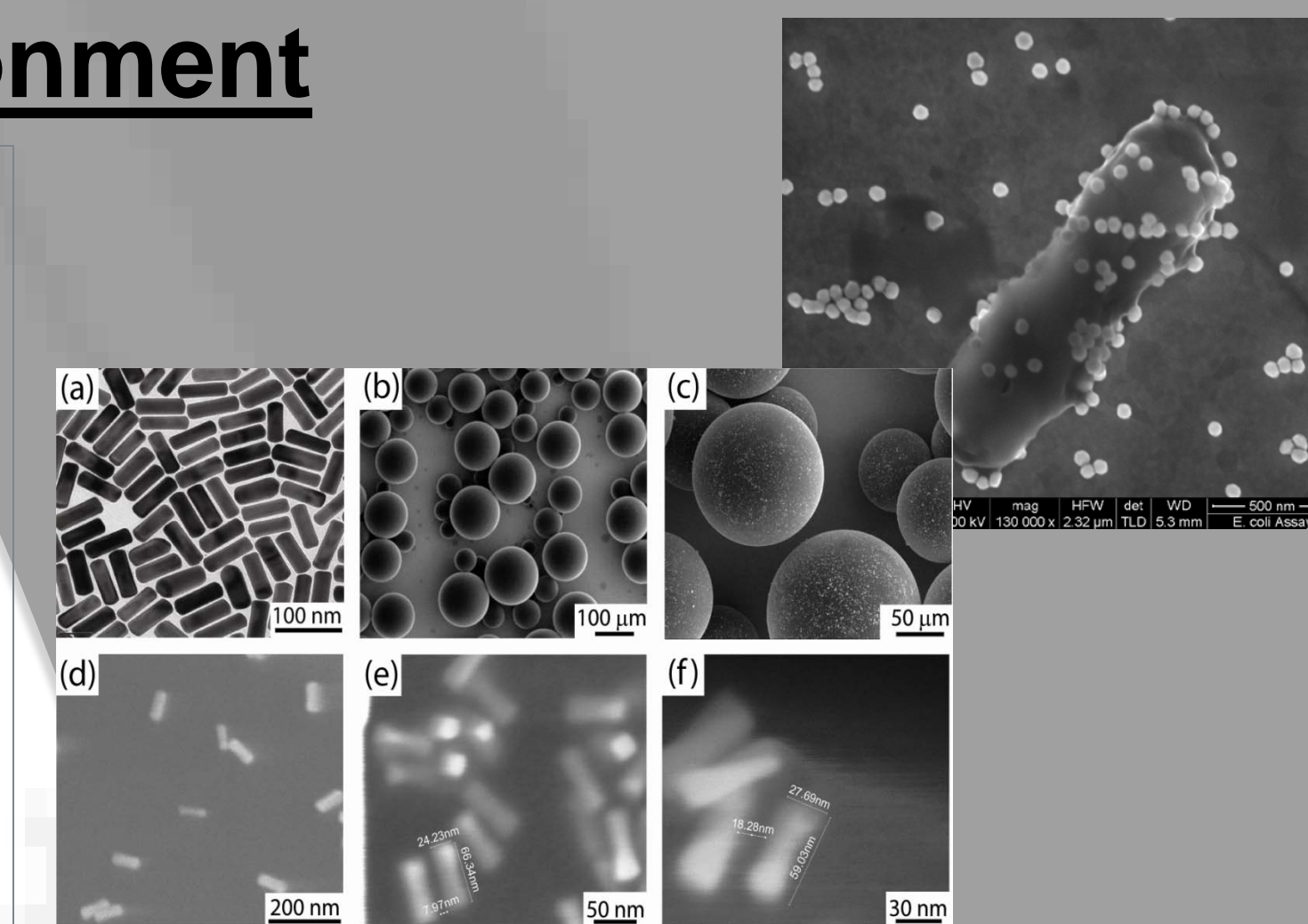


Interdisciplinary Educational Environment

Courses:

The U has created a new generation of nanoscience and nanotechnology oriented courses at the undergraduate, graduate and professional levels. Faculty members from the Departments of Chemistry, Biology, Physics and Materials Science & Engineering have, for example, developed interdisciplinary undergraduate courses and graduate courses in nanoscience (BIOL/CHEM/PHYS 5810), nanobiotechnology (MSE5071), and nanoanalytics (CH EN 7960). Additionally, lectures in nanotherapeutics and diagnostics are taught by Institute members to professional students at the U and to entry and graduate level engineering students. There are also plans to develop these lectures into new graduate courses on nanomedicine. All of these courses feature guest lecturers from the Colleges of Engineering, Sciences, Pharmacy, and the School of Medicine, as well as external speakers, and cover emerging topics on nanomaterial design and characterization, drug delivery, bioimaging, subcellular trafficking, toxicology, diagnostics, clinical translation, and regulatory issues. These courses will play a crucial role in the creation of interdisciplinary, inter-campus undergraduate and graduate program concentrations in nano- or nanobio-technology.

Additionally, a science and engineering proposal has recently been funded by the NSF to provide integrative graduate education and research training (IGERT) in the areas of nanobiosensors, nanomaterials and microfluidics. More recently, a training grant on nanotherapeutics has been submitted to the NIH. These types of programs will dovetail seamlessly with the overall educational goals of the Institute, promoting excellence in graduate level nanoscience and nanotechnology education as well as post-graduate preparation for real-world applications.



Interdisciplinary Team Environments:

Interdisciplinary interaction within course development is key to teaching and learning strategies at the U. Each course is developed and run by multiple faculty members from a variety of different departments (Engineering, Pharmaceuticals, Biology, Chemistry, etc). The courses are cross listed across multitude of different departments, eliciting a varied background within the course's student population. This variety provides an ability to subdivide the students into teams based on expertise. Each student then has the ability and potential to contribute to team building exercises with varied approaches and ideas. This facilitates individual learning not only in a structured lectured environment from faculty experts but allows students to learn from one another and develop essential team skills.



Interdisciplinary Outreach Environment

nanoUtah



Seminars and Symposia

The Institute invites world class nanoscience researchers to participate in its monthly seminar series. Members also actively organize the annual nanoUtah symposium which focuses on the latest developments in nanotechnology and nanoresearch. The nanoUtah symposium features a key note speaker internationally recognized in the field, with invited lectures and posters from researchers in academia, industry and government, including many of the Institute members. Emphasis is placed on engaging trainees and young scientists to actively participate in the organization of seminars and conferences, and in disseminating of their findings through established scientific channels. In addition, the U hosts international symposia in all areas of nanotechnology; members of the Institute are fully involved in planning and conducting these symposia.

Outreach

The Institute works with local libraries and universities to organize informal education activities for the public, create public awareness through events like NanoDays, and attract nanotechnology museum exhibits to Utah.



The Interdisciplinary Connection



Lessons:

The Nano Institute of Utah functions as an auxiliary body for the representation and development of the Utah nanotechnology community. Through the development and constant refinement, we will unify nanotechnology disciplines and advance professionals, trainees, young scientists and the community through educational, professional and outreach opportunities. In the development of interdisciplinary collaborations at both the professional and student levels. This approach has facilitated different access points to information and innovative informal educational outlets. Formal education environments stimulate knowledge but the real learning takes place in day-to-day interactions. Through the development of outreach, seminars, symposia, etc we will inspire a new generation of nanoscientists and engineers to bring forth a tradition of collaboration, communication and innovation to present solutions for present and future nanotechnology challenges.



Future Challenges:

A constant battle exists in uniting differing disciplines and maintaining interest from professional, trainees, young scientists, as well as the general public. Involvement, activism, effective distribution and access to information will be key in maintaining momentum. More defined training programs, such as a recently funded NSF-IGERT and submitted NIH training grant proposals, will drive the program forward and produce competitive educational and work-force training programs. It is vital that these programs train quality individuals who understand the importance and can facilitate an interdisciplinary work force in industry and in academia.

