

New Year, New Opportunities

Welcome back!

We look forward to an exciting new year and winter academic quarter at UC San Diego.

To recap last quarter and last year, we saw a seminar hosted by graduate student Ronnie Fang, the NanoEngineering Faculty mixer, and a Graduate Student Panel. Photos from the events held on campus are posted on our website, <http://nets.ucsd.edu/>. For the first time, a team from UCSD participated in the International Bio-Molecular Design (BIOMOD) Competition and won the Silver Project Award. In the NanoEngineering Department, we witnessed the creation innovative solutions ranging from a faster process for 3D printing at a nanoscale resolution to new drug-carrying nanoparticles to fight cancer. In this newsletter is a snapshot of these happenings.

For the winter quarter, the goal of the NETS Board is to create more opportunities through possible outreach programs and collaboration with other student-run engineering organizations and new connections local to San Diego. Please watch for new involvement opportunities, and if you have ideas for the future, please send us an email at nets@ucsd.edu.

We encourage your input and participation.

Sincerely,
Duncan McClure
NETS Board

Keep Up To Date

- Sign up for our mailing list. Please send an email to nets@ucsd.edu
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Dr. Andrea Tao

NanoEngineering In the News

PhD student **Inanc Ortac**, currently working with **Dr. Sadik Esener**, won first prize in the graduate student category at the 2012 Collegiate Inventors Competition. Ortac's winning entry, "Nano-Wiffle-Balls for Cancer Therapy" offers a new, targeted drug delivery method that minimizes damage to non-cancerous cells around the affected area.

The nano-wiffle-balls, which are porous silica capsules approximately 1/1000th of the thickness of a human hair, are first filled with foreign enzymes and sealed. These devices effectively hide the enzymes from the body's immune system and can accumulate at cancer sites due to the incomplete and leaky, nature of the vasculature around tumor tissue. Next, a drug precursor, "prodrug," is administered. When the prodrug reaches the tumor site, it reacts with the enzyme cargo and becomes an active cancer-fighting drug, at cancer sites where the nano-wiffle-balls accumulate.

"With our nano-wiffle-ball technology, we expect that the lethal side effects to chemotherapy can be greatly reduced, the efficacy of the therapy can be increased, and the quality of life of patients can be improved," said Ortac, as reported in the Jacobs School news release; http://www.jacobsschool.ucsd.edu/news/news_releases/release.sfe?id=1284

Researchers working with **Dr. Shaochen Chen** have developed a new biofabrication technique that can create microscale three-dimensional structures out of soft, biocompatible hydrogels within seconds. Reported in *Science Daily* and the journal *Advanced Materials*, this new process, called dynamic optical projection stereolithography (DOPsL), can achieve the nanoscale resolution required to match fine-grained details of natural tissues. This is essential for printing blood vessels, which are needed distribute nutrients throughout a tissue.

DOPsL uses a computer projection system with precisely controlled micromirrors to shine light on an area in a photosensitive biopolymer and cell solution and solidifies layer by layer. This is part of a new biofabrication technology that Chen is developing under a four-year grant from the National Institutes of Health. Further information is published in an article by Science Daily; <http://www.sciencedaily.com/releases/2012/09/120913162710.htm>

Researchers working with **Dr. Liangfang Zhang** have developed a method to disguise nanoparticles carrying cancer-fighting drugs as red blood cells, which allows them to evade the body's immune system and deliver their contents straight to a tumor and involves collecting the membrane from a red blood cell and wrapping it around a biodegradable polymer nanoparticle stuffed with small drug molecules.

This marks a significant shift in focus and breakthrough in the field of personalized drug delivery research since it bypasses the fundamental biology underlying the functions of surface molecules on a red blood cell and uses the membrane of one itself, instead of attempting to mimic it artificially. This research was published online in an Early Edition of the *Proceedings of the National Academy of Sciences*.

The study was funded through a grant from the National Institutes of Health. According to Dr. Zhang, one of the next steps is the development a method for large-scale manufacturing of these nanoparticles for clinical use, which will be funded by the National Science Foundation. More information is available through a Jacobs School news release; http://www.jacobsschool.ucsd.edu/news/news_releases/release.sfe?id=1086

According to researchers working with **Dr. Shirly Meng**, "choosing the best cathode material used in a Li-ion battery is one of the most crucial issues in achieving higher energy densities, since the energy density is directly correlated to the specific capacity associated with that cathode material. The conversion type materials have been studied as potential electrode materials for higher energy lithium ion batteries (at least double the energy density of today's technology)." They investigated the NiF₂ based conversion materials and the conversion reaction includes the nucleation and growth of nanosized Ni particles, as published in *Electrochimica Acta* 2012, 59, 213 by Ph.D. candidate **Daniel Lee** and colleagues.

"With our nano-wiffle-ball technology, we expect that the lethal side effects to chemotherapy can be greatly reduced, the efficacy of the therapy can be increased, and the quality of life of patients can be improved,"

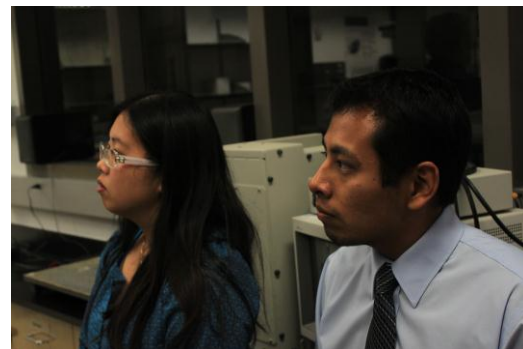
In the News – From Page 2

Meng's group also recently reported the low coordinated geometries on the surface of the oxides can result in spin states that are distinct from the bulk. Consequently, unique magnetic and electronic properties arise and alter the materials performance in devices. Lithium cobalt oxide (LiCoO₂) has been the most widely used positive electrode material for lithium ion batteries for nearly two decades. In recent years, it has been demonstrated that ultra-fast charge/discharge rate capabilities can be achieved in this compound when nanoscale particles with morphology optimal for Li intercalation are prepared and tested. We presented in this work that this can similarly be explained by the presence of intermediate spin (IS) or high spin (HS) Co³⁺, a phenomenon which alters the lithium (de)intercalation voltage significantly. This work is recently published by Ph.D. candidate **Danna Qian** and colleagues in Journal of the American Chemical Society, 2012, 134(14), 6096.

Another way to achieve utmost power density without much sacrifice of energy density is to use nano-structured electrodes, since it makes it possible to reduce the diffusion lengths and its relatively large surface area will reduce the resistance to interfacial reactions and thus accelerate electrode kinetics. PhD student **Hyung-Man (Josh) Cho** prepared the nano-structured electrode of spinel materials via the sol-gel based template synthesis. The diameter of a nano-wire is about 140 nm, and its length is about 12 μm. The nano-structured electrode improves the power density of the battery significantly. In order to investigate the contribution of the elementary reaction steps to the power performance, the electrochemical impedance spectroscopy (EIS) is measured at the state-of-charge. It proves that the contribution of the interfacial charge-transfer and solid-state diffusion impedances were reduced drastically in such nano-structured electrode.

Credit to PhD students Danna Qian and Hyung-Man (Josh) Cho for providing the above information for publication in this newsletter

Fall 2012 In Pictures



Above: Scene from the Lab tour in the SME basement

Left: Students and Dr. Andrea Tao at the Faculty Mixer

Below: Dr. Darren Lipomi introduces himself at the Faculty Mixer

Upcoming Events

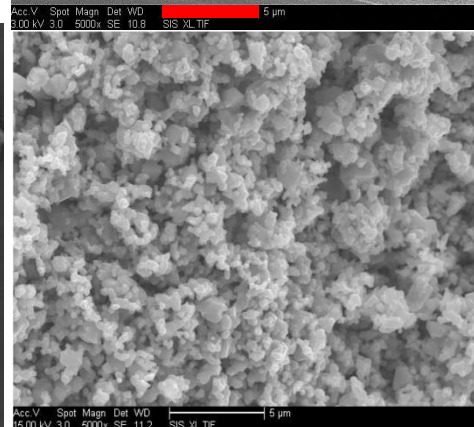
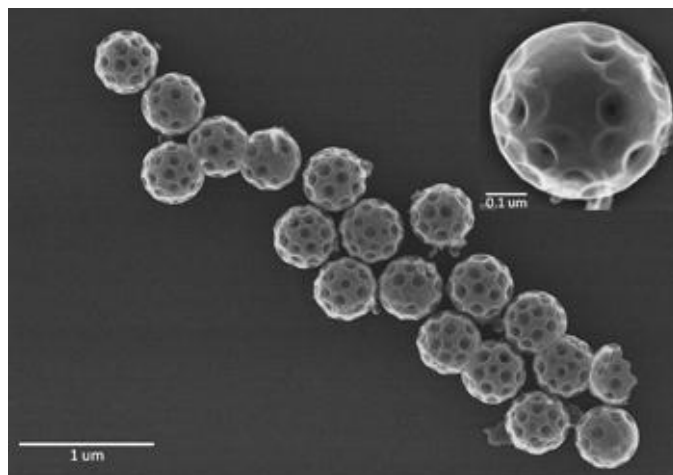
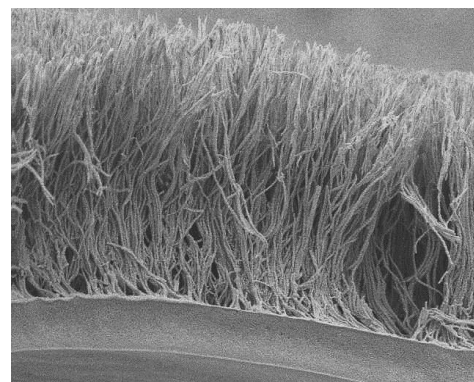
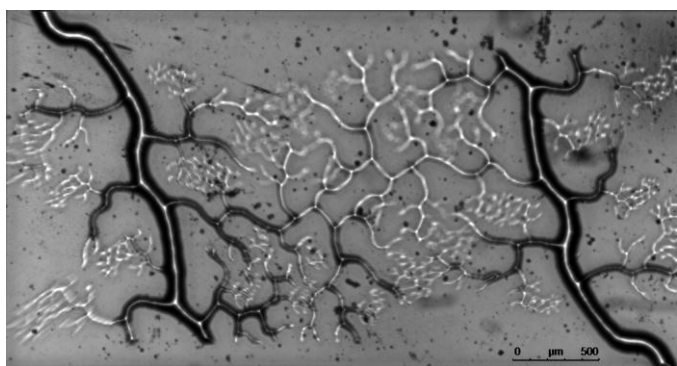
- Week 2: GBM and Resume Workshop
- Week 3: Social
- Week 4: Seminar with Dr. Darren Lipomi
- Week 5: Resume Critique with NE Professors
- Week 6: Interview Workshop
- Week 7: E-Week
- Week 8: Class Planning/Focus workshop
- Week 10: Study Area

Details are subject to change. Please stay updated



Newsletter and event photos by Duncan McClure

Please send any questions, comments, or feedback to dmcclure@ucsd.edu



Graphics 2012

Clockwise from top right,

- (1) three-dimensional blood vessels printed using new DOPsL process, image provided by Dr. Shaochen Chen*
- (2) Scanning electron micrographs of (a) $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$ nano-wires and (b) illustrating the texture of other electrode materials created images provided by Dr. Shirley Meng and Hyung-Man (Josh) Cho*
- (3) Nano-Wiffle-Ball capsules for cancer-fighting drug delivery, image provided by Inanc Ortac,*

