

Clean Green IGERT Newsletter



<http://cleanenergy.ucla.edu>

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Highlights from the Clean Energy for Green Industry Traineeship for Graduate Studies at UCLA



(l-r): Igor Bogorad, Alexander Williams, Benjamin Feinberg, Leland Smith, Ian McKinley, Omar Asensio, Razmig Kandilian, Brian Roizen, Johnny Chen, Jaime Torres, David Watts

Clean Green IGERT Trainees 2010-2011

This year 11 new trainees joined the CGI program for a program total of 17. Additionally, 3 faculty advisors joined CGI as well. The advisors are **Prof. James Liao** (Chemical & Biomolecular

Engineering; CGI focus: energy harvesting), **Prof. Eric Hoek** (Civil & Environmental Engineering; CGI focus: energy conservation), and **Prof. Chang-Jin Kim** (Mechanical & Aerospace Engineering; CGI focus: energy storage). The trainees they are mentoring are conducting research in biofuels and fuel cells. (More on the new trainees on page 2.)

Meet the New CGI Trainees

Omar Asensio (Institute of the Environment and Sustainability, advisor Prof. Magali Delmas) analyzes corporate strategies for environmental sustainability, clean energy growth and innovation. CGI role: brown bag series.

Igor Bogorad (Chemical & Biomolecular Engineering Dept, advisor Prof. James Liao) combines computational models with directed evolution to synthesize de novo enzymes involved in cellulosic degradation for renewable biofuel production. CGI role: president.

Johnny Chen (Materials Science & Engineering Dept, advisor Prof. Yang Yang) develops new potential in synthesizing low-bandgap polymers to realize highly efficient organic solar cells.

Benjamin Feinberg (Civil & Environmental Engineering Dept, advisor Prof. Eric Hoek) studies microbial fuel cells. CGI role: city/industry liaison.

Razmig Kandilian (Mechanical & Aerospace Engineering Dept, advisor Prof. Laurent Pilon) advances the development of waste heat harvesting using pyroelectric materials.

Ian McKinley (Mechanical & Aerospace Engineering Dept, advisor Prof. Laurent Pilon)

extends the use of infrared pyroelectric sensors to nanoscale thermal radiation and develops a novel direct pyroelectric energy converter using nanoscale radiation. CGI role: conferences.

Brian Roizen (Mechanical & Aerospace Engineering Dept, advisor Prof. Chang-Jin Kim), designs and fabricates a millimeter scale fuel-cell system with low energy requirements. CGI role: media relations.

Leland Smith (Materials Science & Engineering Dept, advisor Prof. Bruce Dunn) conducts research on electric double-layer capacitors. CGI role: city/industry liaison.

Jaime Torres (Chemistry & Biochemistry Dept, advisor Prof. Richard Kaner) studies carbon-based nanomaterials for use in energy harvesting and storage. CGI role: city/industry liaison.

David Watts (Chemistry & Biochemistry Dept, advisor Prof. Sarah Tolbert) studies electrochemical methods to generate energy.

Alexander Williams (Materials Science & Engineering Dept, advisor Prof. Richard Wirz) designs and models solar thermal storage using supercritical fluids. CGI role: conferences.

Brown Bag Seminars

Since the beginning of the CGI program, the fellows have met biweekly for brown bag seminars, a series of informal talks. During the first year, the guest speakers were CGI faculty members who presented their research as it relates to clean energy science and policy to familiarize the new fellows with the research being conducted in the CGI circle.

For the second year, the circle has been expanded and the fellows have invited speakers that they have interest in. The speakers so far have included: **Prof.**

Matt Kahn (Institute of the Environment and Sustainability) who discussed climate change adaptation and themes from his third and latest book *Climatopolis*; **Michael Swords** (Executive Director of UCLA Strategic Research & Global Partnerships) who discussed Clean Tech LA and partnership with the Los Angeles Mayor's Office; **Prof. Deepak Rajagopal** (IOES) who discussed life cycle assessment (LCA) methodologies for biofuels and energy policy; **Earl Weinstein** (UCLA Office of Intellectual Property) and **Dr. Shahin Farshchi** (Lux Capital Management) who discussed patenting strategies and intellectual property.



New trainees getting to know each other at the Faculty & Fellows Mixer
 Pictured (L-R): Alex Williams, Brian Roizen, Razmig Kandilian, Igor Bogorad

Faculty & Fellows Mixer

The new trainees for the 2010-2011 academic year were welcomed at the Faculty & Fellows Mixer on September 30, 2010 at the California NanoSystems Institute (CNSI). They were joined by the continuing trainees from the 2009-2010 academic year, faculty advisors, as well as **Prof. Paul Weiss** (Chemistry & Biochemistry), Director of CNSI.

Current Events in Clean Energy

Trainees **Leland Smith** and **Rita Blaik** (advisor Prof. Bruce Dunn), under the direction of **Andris Abele** (UCLA Institute for Technology Advancement), are conducting a study under the California Energy Commission (CEC) on electrochemical

energy storage systems which will be available in the 3-10 year timeframe as defined by California bill AB 2514. AB 2514 will require electrical companies and utilities to "procure new energy storage systems, as defined, that are sufficient to provide specified percentages of the utility's average peak electrical demand using stored energy that was generated during off peak periods of electrical demand (energy storage portfolio)." This is in order to serve the needs of a grid that will become increasingly reliant on alternative energy sources such as solar and wind, which provide energy intermittently.

Several trainees attended the "Proposition 23 and the Future of California's Economy and Environment" debate held at UCLA in October 2010. The

proposition would suspend AB 32, the Global Warming Solutions Act that requires reduced greenhouse gas emissions, until California's unemployment rate drops to 5.5% or below for four consecutive quarters. Current events such as this further emphasize the topicality of the CGI program in addressing clean energy science with business and policy.

Research Highlights

Brion Bob (advisor Prof. Yang Yang) co-authored a paper published in *Chemistry of Materials*. The paper is entitled "Identification of the Molecular Precursors for Hydrazine Solution Processed $\text{CuIn}(\text{SE},\text{S})_2$ Films and Their Interactions". Using Raman spectroscopy, Bob was able to simultaneously probe the vibrational modes of a variety of solvated species in the study of hydrazine-based systems, suggesting it is possible to achieve high quality semiconductor films at low fabrication temperatures. This has tremendous potential for application to flexible solar cells, displays, and other electronics.

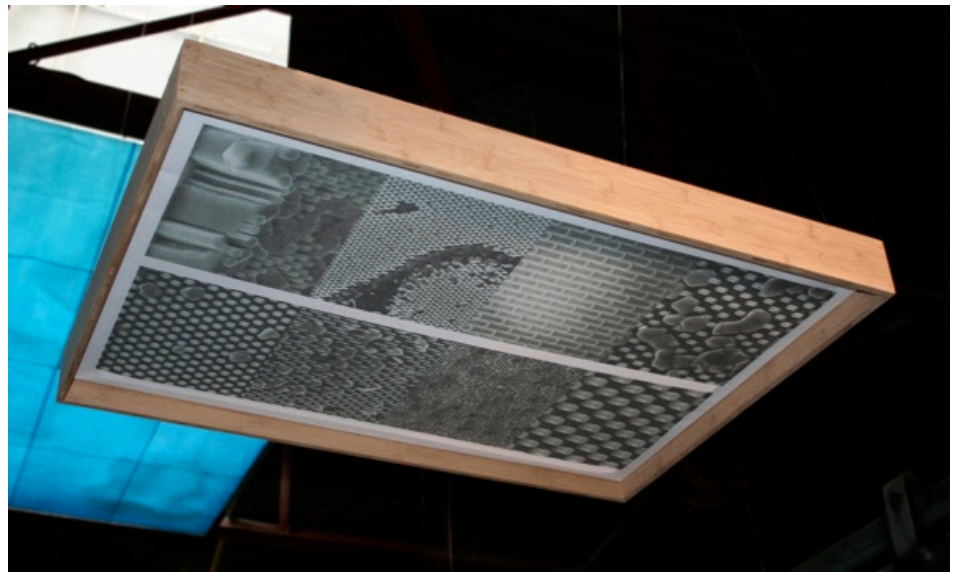
Joshua Shapiro (advisor Prof. Diana Huffaker) co-authored a paper published in *Applied Physical Letters*. The paper is entitled "InGaAs heterostructure formation in catalyst-free GaAs nanopillars by selective-area metal-organic vapor phase

epitaxy". Both Shapiro and trainee **Alexander Williams** are co-authors on two other papers on nanopillars currently under review or in preparation.

Shapiro has also filed a provisional patent on a technique for forming axial heterostructures in catalyst-free nanopillars formed by selective area epitaxy, which may be used for the development of optoelectronics with improved performance and sensitivity including detectors, lasers, and photovoltaics.

Razmig Kandilian (advisor Prof. Laurent Pilon) co-authored a paper that has been accepted for publication in *Smart Materials and Structures*. The paper is entitled "Pyroelectric Energy Harvesting Capabilities of PMN-PT Near the Morphotropic Phase Boundary".

Several trainees also have papers in preparation. **Jaime Torres** (advisor Prof. Richard Kaner) for his research on growing single or bilayer graphene using ethane. **Ian McKinley** (advisor Prof. Laurent Pilon) for his research on waste heat energy harvesting capabilities of <001>poled PZN-5.5PT. **Benjamin Feinberg** (advisor Prof. Eric Hoek) for the modeling of salinity gradient energy production (pressure retarded osmosis and reverse electrodialysis).



Creative Economy: Cultivating Fields of Technology

Art & Science

Trainee **Joshua Shapiro** (advisor Prof. Diana Huffaker) and his wife, artist Eloisa Guanlao, collaborated on an art installation entitled "Creative Economy: Cultivating Fields of Technology", which won best SEM image from the MNA Lab and second place for the FEI Tony Award at the recent NSF Art Competition. The project draws parallels between modern material, GaAs nanopillars grown in regular arrays, and traditional crops, such as rice and bamboo, which are also grown in large fields. The images of nanopillars were printed on rice paper and mounted in bamboo frames.

Trainee **Rita Blaik** (advisor Prof. Bruce Dunn) is pursuing science writing in the field of new media as part of her integrative studies and attended the Blogworld & New Media

Expo held in October 2010 in Las Vegas. Blaik started *The Third Kind*, a blog on art, science, and "the third culture" as defined by John Brockman. (<http://thethirdkind.tumblr.com>)

Partnership

Trainee **Joshua Shapiro** (advisor Prof. Diana Huffaker) is working on a collaboration studying the optical characterization of nanopillars with Prof. Ken Shih at the University of Texas at Austin.

Trainee **Alexander Williams** (advisor Prof. Richard Wirz) is currently working on a collaboration with COMSOL modeling software.

Trainee **Igor Bogorad** (advisor Prof. James Liao) has been involved in a new collaboration conducting quantum chemical calculations on an enzyme with the Chemistry Department.



Prof. Laurent Pilon presents the new Clean Energy courses at the second annual CGI Open House (November 2010)

Trainee **Mark Lewis** (advisor Prof. Kang Wang) interned at IBM over Summer 2010. As part of the 3D Integration group who are researching processing for integrating multiple chips into one 3D package, Lewis worked on the deep silicon etch towards achieving through silicon vias (TSVs).

Prof. Eric Hoek has been working with BP engineers to deploy prototypes of oil-water separation technology to aid in the Gulf of Mexico oil spill that occurred in April 2010 and has made several trips to the region.

Open House

CGI hosted our second annual “Open House” on November 22, 2010 to attract undergraduate seniors in Southern California who are seeking to earn a PhD in clean energy related fields. Speakers included several CGI faculty and

trainees, who presented their research, the CGI program, and related sustainability efforts at UCLA and in Los Angeles, as well as affiliate **Michael Swords** (Executive Director of UCLA Strategic Research & Global Partnerships), who presented the CleanTech Corridor and Clean Tech LA. This year **Prof. Laurent Pilon** introduced three new innovative courses in clean energy science and technology designed specifically for CGI by our participating faculty members.

New Courses in Clean Energy

This academic year saw the introduction of new courses in clean energy developed by CGI faculty members. The first in the series, Introduction to Clean Energy Science and Technology, was offered in Fall 2010 as EE 279AS and MAE 236. This lecture course covered energy policies

and business, energy generation, energy storage, and energy efficiency. The course is uniquely taught by several CGI faculty, each covering their area of speciality, as well as guest lecturers from campus and Los Angeles. The second course in the series, Advanced Clean Energy Science and Technology, will continue these topics in more depth and is being offered as MAE 298 in Spring 2011. The third course is a laboratory course with experiments in clean energy technologies and is set to be offered in the 2011-2012 academic year. These courses are required for CGI trainees and are open to other graduate students as well.

The work of the trainees from the first course, EE 279AS/MAE 236, will be the basis for a special issue of the student-run *Bruin Business Review*. Topics will include micro wind technology, energy storage, solar thermal, high performance photovoltaics, as well as policy features in carbon trading and California’s AB 32. This project is being led by trainee **Omar Asensio** (advisor Prof. Magali Delmas) and Christopher Young (BBR).

Conferences

Prof. Magali Delmas and trainee **Nicholas Nairn-Birch**’s co-authored paper, “Is the Tail Wagging the Dog? An Empirical Analysis of Corporate Carbon Footprints and Financial Performance” (for more details on

the paper, please see Newsletter Vol. 1), has been selected for the Academy of Management Conference in August 2011 in Dallas, Texas.

Amy Ferreira (advisor Prof. Sarah Tolbert) was credited for her research contribution to “Optimizing nanoscale architecture in semiconducting polymers” which was presented by the Tolbert group at the American Chemical Society (ACS) National Meeting & Exposition held in March 2011 in Anaheim. Also at the ACS National Meeting, **Prof. Sarah Tolbert** presented the CNSI High School Nanoscience Program, which she is the head of, as part of the High School Chemistry Day for teachers.

Outreach

All of the CGI trainees continue to work with the CNSI High School Nanoscience Program to instruct high school teachers in the Los Angeles Unified School District by conducting nanoscience experiments that they may take back to their classrooms. The eight experiments include take home kits for the teachers and will give their students hands-on experience with materials, methods, and devices, including self-assembly, magnetic fluids, chemical sensors, solar cells, photolithography, superhydrophobic surfaces (or the lotus effect), water filtration, and the toxicity of nanoscale systems compared to similar materials in bulk form.



(L-R) Trainees Leland Smith, Razmig Kandilian, and Johnny Chen assist with the CNSI High School Nanoscience Program

Prof. Chang-Jin Kim conducted the Superhydrophobic Surfaces Workshop as part of the CNSI High School Nanoscience Program in December 2010.

Trainee **Brion Bob** (advisor Prof. Yang Yang) is also active with the High School Summer Outreach Program run by the Engineering Graduate Student Association, where he has led dye-sensitized solar cell workshops using raspberry juice and titanium dioxide.

The CGI trainees are currently developing a “Clean Energy Road Show” to present at schools in Los Angeles. The demonstrations will include a hand-cranked electric generator, thermoelectrics, solar panels, stirling engine, fuel cells, and a rudimentary steam engine. The goal of this program is to map out for students the basic infrastructure that connects their household electronics to various resource streams that generate

electricity. The show is expected to hit the road in May 2011.

Trainee **Jaime Torres** (advisor Prof. Richard Kaner) helped to organize the inaugural Clean Tech LA Career Night which was held at the University of Southern California on February 1, 2011. Over 100 MBA and engineering graduate students from UCLA, USC and Cal Tech attended to meet with representatives from 21 clean technology companies in Southern California.

Trainee **Ian McKinley** (advisor Prof. Laurent Pilon) will be leading a session during the Spring Quarter on rockets for the “How It Works” class at a middle school in Sherman Oaks.



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