

Garcia Center Leads Students from the Materials Laboratory to the Real World

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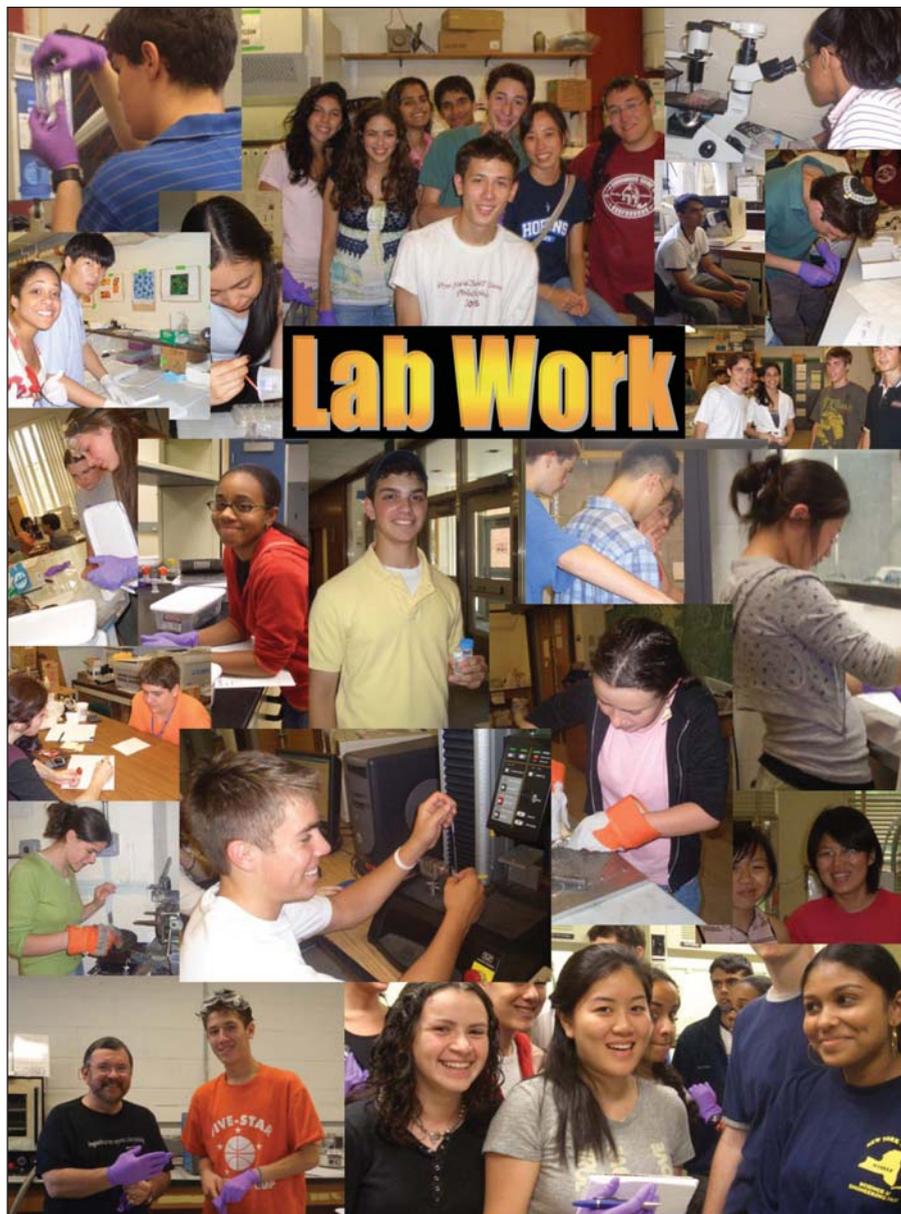
"The usual academic environment provides training that is heavily biased toward individual achievement, and rewards individual accomplishment," said Miriam Rafailovich, director of the Garcia Center for Polymers at Engineered Interfaces at the State University of New York at Stony Brook; "Our goal is to demonstrate that an educational platform can be built which prepares the students for the real world environment where collaborative research is the norm."

At the Garcia Center, supported in part by the Division of Materials Research (DMR) at the National Science Foundation (NSF), research groups consist of individuals of wide educational levels and experience. Particularly unique about this Center is the incorporation of a very large number of high school students in its research program.

Each summer, a group of about 60 high school research scholars, approximately 20 undergraduate students, and five high school teachers, who come from across the United States—and recently as far as Germany, France, Israel, Korea, and Taiwan—join the regular staff of graduate students, postdoctoral associates, and university faculty in a journey into the world of materials research. Even though the activities begin as part of an organized summer program, they eventually develop into a quest for lifetime discovery, learning, and networking.

The program, known as the Garcia Research Scholar Program, combines formal and informal instruction which gives the students a sound foundation in the fundamentals of research that also stresses the importance of innovation. To help the high school students feel comfortable in the college environment and unafraid to think and explore, the program combines formal lectures and open-ended research with many opportunities for the students to socialize and develop other talents.

For the first two weeks of the Research Scholar Program, high school students participate in a research "boot camp." During "boot camp," they receive intensive training by the laboratory staff on laboratory techniques, safety protocols and waste disposal, basic statistics, data-base mining, intellectual property, and ethical conduct. Throughout this period the students are divided into small groups, with experienced mentors from the Research Experiences for Undergraduates (REU) and Research Experience for Teachers (RET) programs also funded at Garcia by DMR. The mentors help facilitate the transition



Students experience "real life" collaborative research in the laboratory at the 2006 Research Scholars Program of the Garcia Center for Polymers at Engineered Interfaces.

from the structured high school environment into the open-ended research mode.

After "boot camp," the high school students perform a week-long experiment while being closely supervised and taught how to work in a group, giving proper credit and incorporating techniques they have just learned. Senior guest speakers are invited to introduce the students to various research directions available to them in the laboratory.

During this time, the students are divided into smaller working groups, which hold journal club sessions. Each student in the group has a chance to read and present a scientific paper to the group during a pizza luncheon. Sometime within the third week, the students are guided into selecting their research projects. The research work during this time is punctuated with Friday barbecues on the lawn at Stony Brook, and group trips with fun

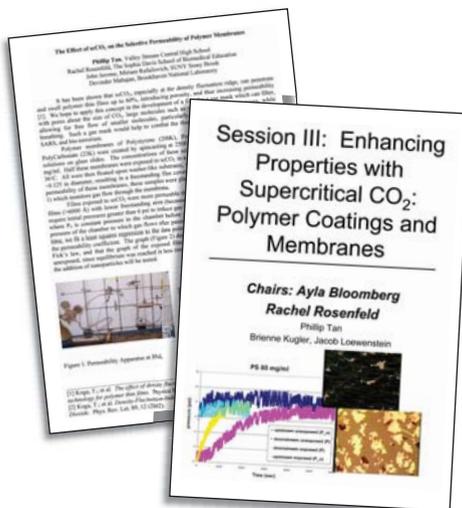
and science in mind. This past year (2006–2007), many of the students were interested in environmental causes, so a trip was selected with the faculty of the Stony Brook School of Marine Sciences where they did trawling in Southampton to explore the effects of materials pollution. In previous years, the students visited the Suffolk County Police Forensics Laboratory, where they explored the science of the Crime Scene Investigators; and they visited Brookhaven National Laboratory, where they walked through the Isabelle tunnel and learned how Homeland Security monitors the build-up of nuclear arms in sensitive countries.

After the fourth week of the program, the research projects are well under way. Interdisciplinary support groups are then built around the projects to assist the high school and undergraduate students. The projects are initially led by one or more faculty members, who have a broad overview of the problem. In time, the high school and undergraduate students assume greater roles and eventually become responsible for their projects. Partnerships with graduate students are encouraged. The students report on their progress at group meetings once a week.

Teaching is central to the dynamics of the Center. Although graduate students are themselves mentored by faculty and postdoctoral associates, they have an important role as teachers and mentors of undergraduate students, and high school students and teachers. This provides graduate students with an opportunity to develop teaching and leadership skills in an informal setting. Mini-groups formed around graduate students tend to meet daily during the summer to discuss the status and plans of the group's projects.

In the last few weeks of the summer program, activities can reach a fever pitch with some students staying at the laboratory over night to finish their projects. To break the tension, the teachers in the RET program have organized annual baseball games with teams such as the "Thin Films" versus the "Bionics." At the end of the seven weeks, the students organize a science symposium with multiple sessions open to the public, and especially for their parents and school science coordinators and teachers. The symposium is modeled after the Materials Research Society meetings and the REU students serve as session chairs. The students publish a "year book" consisting of research abstracts and pictures which is distributed at the symposium.

Successful research projects are frequently expanded upon by the graduate students after the summer period, and togeth-



Pages from the 2006 Abstract Book.

er with the high school students, the work is submitted for publication, conference presentation, and/or patent disclosures.

For the period 2006–2007, 13 graduate students received PhD degrees and all found professional employment within six months of graduation. For the same time period, the Center reported 42 publications, 10 patent disclosures, two awarded patents, and 45 conference presentations. All participants had strong conference participation, with a group with strong involvement by high school students winning one of the poster awards at a Materials Research Society meeting. Postdoctoral and graduate students were involved primarily in publications, although two manuscripts—one in *Physical Review Letters* and another in *Macromolecules*—appeared with high school students as the first authors. High school students had the largest contribution to new patent disclosures, and two students were awarded full patents. This outcome is consistent with the observation that these students, unencumbered by thesis obligations, can focus on high risk research.

Also for the 2006–2007 period, Garcia Center high school students provided two of the six team entries in the national finalists of the Siemens-Westinghouse competition, eight semi-finalists and one finalist in the Intel competition, 50% of the New York delegation to the Intel-ISEF competition, and two of the five inductees to the National Gallery for American Young Inventors.

Notable winners of past competitions include Shira Billet and Dora Sosnowik of the Stella K. Abraham High School for Girls, who placed first in the team category of the 2001 Siemens-Westinghouse Science

and Technology competition. They shared the \$100,000 first prize for their original work on the development of a viscometer for ultrathin films. This work initiated a larger study on the effects of surface interactions on thin film viscosity which was eventually published in the journal *Macromolecules* [38 (12) (2005) p. 5144] and cited in the thesis of two graduate students, Chun Hua Li and Sarika Sharma.

One of the 40 finalists in the 2006 Intel Science Talent Search Competition was Daniel Katz of the Hebrew Academy of the Five Towns & Rockaway, Cedarhurst, who developed a single-step room-temperature synthesis procedure to create folate-coated platinum nanoparticles that destroy cancerous cells while sparing healthy ones; in his nanotherapy approach, cancerous cells, which require high concentrations of folic acid, are "tricked" into absorbing the toxic platinum particles and then shrink and die. These particles are now being tested as possible chemotherapy agents for breast cancer, under the directions of Dr. Basil Rigas, who heads the Cancer Prevention Center at the Stony Brook School of Medicine.

At the Garcia Center, more than two-thirds of the high school students remain through the academic year and half return after high school graduation as part of their NSF-funded REU program. About one-third of the students return for multiple years, after college graduation and eventually graduate or professional school. Most of those that do not return join other REU programs, frequently in other centers where their skills are in demand. Often these students maintain contact with the Center. Several collaborations between the faculty at Stony Brook and faculty at Harvard, Yale, and Duke were nucleated by these students.

The impact of the Garcia Center's integrated research and education efforts are not limited to its immediate neighborhood. Even though most of the students still come from the New York Metro area, some participants now come from across the country, including California, Texas, Michigan, Florida, and the New England states. In an effort to increase the participation of underrepresented minorities in its research program, the Center has initiated a new RET program that targets educators in predominantly minority-serving school districts. In addition, the Center is collaborating with the New York City Board of Education in order to expand independent research programs to high schools throughout the city. "College Now" introduces a selected group of about 100 high school students and their teachers to college-level research activities, while

"College for Kids" focuses on weekend science activities for inner city children in the 8–12-year age range. The Center has some success in bringing high-school-aged minority students together with their teachers to the Center for summer research activities. The Center is actively pursuing to increase the diversity among Center faculty and other senior participants to create a nurturing environment for the students.

The support for the Garcia Center constitutes an important but small part of DMR's

large portfolio of activities that seeks to enhance the integration of research and education. More information on Garcia can be accessed at <http://polymer.matscieng.sunysb.edu>; and DMR at www.nsf.gov/div/index.jsp?div=DMR.

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