Appendix 7: Pennsylvania State University/ Center for Molecular Nanofabrication and Devices Profile

I. Description

Institution: Penn State University
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Title: Center for Molecular Nanofabrication and Devices
Proposal: 0213623
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II. Research Agenda

The *Penn State MRSEC* supports collaborative, interdisciplinary research efforts in the area of nanoscale materials. The research themes of the Center are focused broadly on molecular nanofabrication, complex inorganic materials, and low-dimensional electronic nanostructures. These research themes are integrated with major efforts in educational and industrial outreach. The activities of the Center involve over fifty students and postdoctoral fellows, an approximately equal number of faculty from eight academic departments at the Penn State University Park Campus and Hershey Medical Center, and a number of external academic and industrial partners.

III. Education Activities within the University

Annually our faculty, staff and students offer educational outreach programs reaching approximately 3,500 K-12 students, 30 K-12 teachers, and 35 undergraduates. These programs provide opportunities for students, teachers and anyone with an interest in science to learn about how nanoscience touches our lives and how cutting edge research could change our world in the future. Virtually every graduate student, post doctoral fellow and faculty member of our MRSEC participates in one or more of our education and outreach programs. These programs are designed to communicate the excitement and wonder of science and technology with both general and specialized audiences.

Our summer programs for children are designed to increase interest in science and build self-esteem in students with special attention in including girls and under-represented minority children. During our annual teacher workshop, Center members work with teachers to develop ideas and resources to be used in the teachers' classrooms. Through a joint MRSEC/Physics Department Research Experience for Undergraduates (REU)/ Research Experience for Teachers (RET) site, we offer research projects that give undergraduate students the opportunity to participate in frontier materials research, as well as assisting teachers to bring cutting-edge materials research topics into their classrooms.

IV. Education Activities outside the University

Ideas about nanoscience are disseminated to large general public audiences (over 100,000 museum visitors annually) through our partnership with The Franklin Science Museum of Philadelphia, PA. This partnership has produced our *Materials Matter: It's A Nanoworld After (distributed in 2003)* and *All Nano-Bio: Zoom in on Life! (distributed in 2005)* cart-based museum shows. Each of these shows has been distributed to over twenty science and children museums nationwide. A development team consisting of Penn State faculty, graduate students, and undergraduates worked with museum staff to develop the shows. Development of a third cart based museum show began in November 2004 for distribution in 2007.

Materials Matter includes demonstrations and macro-scale models that explore the "micro" mechanisms behind the unusual and surprising "macro" behavior of materials such as aerogels, shape-memory alloys, polymers, electronic ink, and zeolites. Each demonstration is coupled with a macro-scale model to explain the mechanisms and the principles responsible for the novel behavior. In addition to funding the show development, we also provided demonstrational materials and supplies to equip a show for one to one and a half years at each museum.

Our second cart based museum show highlights processes in the body that occur at the nanoscale as the inspiration for nanotechnology research being done in our laboratories. *Zoom* consists of six hands on demonstrations that teach the principles of nanotechnology through processes occurring within our own bodies. Demonstrations topics include, scale, DNA self assembly, membranes, biological motors, viruses and antibodies, and vision as molecular switches. Included with each copy of the show is a multimedia presentation that includes photographs at the nanoscale and computer animations of each process that is demonstrated for visitors.

In addition to the national distribution of the museum show, two copies of the shows reside at Penn State. These copies are used by Center faculty and graduate students to present the shows locally. We have presented the shows locally over 100 times for classroom visits, visiting school groups, summer camps and workshops.

V. Education Outreach Materials

Description of a recent successful education outreach activity:
In addition to the programs listed above, our MRSEC has teamed with the *Action Potential Science Experience*, an outreach program of the Penn State Eberly College of Science that uses theme based summer programs to teach science topics through novel hands on activities. We have developed a nanoscience and materials wizard themed summer camp for 4^{th}-8^{th} grade students. (This is the third camp in a series of camps based on J.K. Rowling's Harry Potter books.) Our faculty wrote the curriculum for the week long adventure titled *The Adventure of the Apprentice's Stone*. The innovative curriculum combines art, history, science into a weeklong adventure that transports students to the Penn State School of Wizardry. Campers learn about materials and nanoscience while trying to unlock the mysteries of the Apprentice's Stone. Each day of the five day program the activities help to reveal a magical message of the day. When combined at the end of the week, the daily messages unlock the secret of the Apprentice's Stone. Activity topics include ferrofluids, nitinol, zeolites, lithography, and spectroscopy. The camp has been licensed and, along with the other two Potter camps, was presented in the NY Finger Lakes region in the summer of 2005.

VI. Education Outreach Evaluation

Our outreach evaluation to date has been largely short term in nature, post experience surveys at the end of the program, except for our REU and RET programs, which have used pre-surveys, post-surveys and later surveys to track some limited outcomes. Improving the evaluation of our programs is currently a major focus of our education outreach efforts.

VII. Lessons Learned

Don't reinvent the wheel: we like to say that we combine our research expertise with the education expertise of existing programs.

Concept of scale is a starting point for all of our education outreach programs.