



# The NNIN Science News Magazine for Kids

*Exciting, Educating, and Challenging both Students and their Teachers about Science and Nanotechnology in Today's World.*

*How many "pixels" are in your eye?*

*What is nano about your sense of smell?*

Many young students have heard about "nano" but don't really know what it is. "Nanooze" is a vehicle to take advantage of that natural interest, bringing the excitement of science and nanotechnology to young children at a level they can understand and in a language and style they relate to. Content draws on science in the news and science in everyday lives, and relates, as enrichment material, to standard science curriculum at the middle school level.

The target is the "post-atomic" kid, i.e. a student who knows about atoms or molecules but doesn't yet know what it all means in real life. In general that is the middle school level, although the content is adaptable across a wide range of ages and interests.

Nanooze is available on the web in English, Spanish, and Portuguese. In addition, fifty thousand printed copies are distributed 3 times per year to classrooms across the US, free of charge. Recent issues have explored nanotechnology and the five senses, a new twist on a topic which is addressed in many middle school biology classes and a topic to which students can easily relate. A total of seven issues are available. Major (>10,000 copies) distributions have been done to middle schools in suburban Atlanta and metropolitan Detroit; the rest are distributed to individual classrooms on request. Nanooze is produced by a team led by Prof. Carl Batt at Cornell University and distributed by NNIN.

*50,000 printed copies of each issue distributed to classrooms*



*On the web at [www.nanooze.org](http://www.nanooze.org), in English, Spanish, and Portuguese*



*An activity of the Education Program of NNIN, the National Nanotechnology Infrastructure Network, funded by the National Science Foundation as part of ECS-0335765, Sandip Tiwari, Cornell, PI.*

# Nanotechnology Undergraduate Research

*An Activity of the NNIN Education & Outreach Program*

Providing quality initial research experience is a critical part of undergraduate science and technology education. The **Research Experiences for Undergraduates** program provides an avenue for such research and it is particularly critical for students from “non-research” universities. For 13 years, NNIN and its predecessor, NNUN, have conducted a nanotechnology REU program, with up to 80 students at sites across the network. Our program is highly coordinated across the 14 sites with one common application and common set of procedures and expectations. Students conduct a significant individual research project in one of the state-of-the-art NNIN facilities, experience the graduate research environment, and learn a range of nanotechnology tools and processes.

Over 700 students have participated in the NNIN REU program since its inception. Because of its size and long history, our program offers a unique opportunity to gather meaningful, non-anecdotal data on the long term impact of REU on career outcomes. As a student’s career choices play out only after 5-10 years, it is necessary to adopt a long term view to accurately assess program impact. NNIN has collected data from approximately 55% of the first 375 participants (1997-2004). Data show that 86% have gone on to graduate school with 47% completing or nearing completion of a Ph.D. degree. 95% remain in scientific careers. While it is not possible to compare this outcome to a control group, these results and the accompanying comments from past participants, demonstrate the importance of REU programs in the education of the next generation of nanotechnology researchers.



## Longitudinal Study of REU Outcomes

Degrees		Type of Career	
Terminal B.S.	14%	Science Career	95%
Terminal M.S.	26%	Nanotechnology	
Ph.D.	47%	Career	48%
J.D./MBA	8%		
M.D.	5%		

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# Research Experience for Teachers in Nanotechnology

*An Activity of the NNIN Education and Outreach Program*

The NNIN **Research Experience for Teachers** program introduces middle and high school teachers to nanotechnology. The program at 5 NNIN sites serves 20 teachers each year for an 8 week research and curriculum development project. Participants work in NNIN facilities along with NNIN staff and faculty learning the techniques and processes of nanotechnology research.

Middle and high school teachers have direct influence on early stages of the human resources pipeline. As a result of their RET participation, they can relate their direct research experience to the students as well as use new nanotechnology activities to enrich their curriculum content. Because each teacher interacts with hundreds of students in subsequent years, this program has a highly leveraged impact on the scientific human resources pipeline

As part of the experience, each teacher develops a nanotechnology activity suitable for use in a classroom. Each module must examine a nanotechnology concept suitable for middle or high school classrooms while also relating to National and State content standards so that it can be easily integrated into normal curriculum. These lessons and activities are refined with the help of NNIN Education staff, NNIN Technical Staff, and other participating teachers. The resultant activities are posted on the NNIN education web site and are used in other NNIN education/outreach activities. NNIN Education staff follow up with participants in subsequent years to help with classroom implementation.



*An activity of the Education Program of NNIN, the National Nanotechnology Infrastructure Network  
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award EEC-0908895, Nancy Healy, Ga. Tech, PI.*

# Developing Globally Aware Scientists

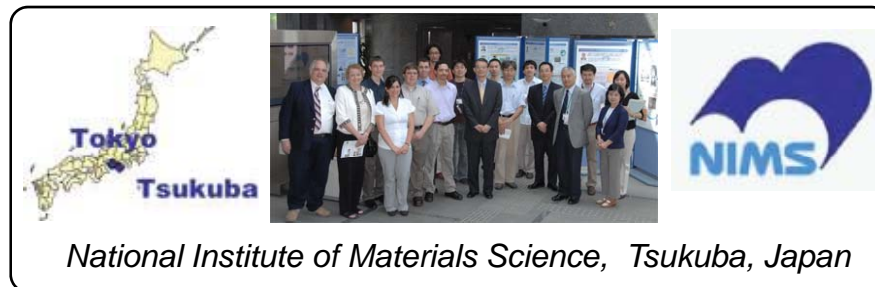
## NNIN iREU

### An Activity of the NNIN Education and Outreach Program

Science in the 21<sup>st</sup> century requires a technology workforce able to compete effectively in a global environment. U.S. students are, however, in general, poorly prepared to deal with the complexity of research in an international context. Issues relate to both culture and communication. This program seeks to expose talented undergraduates to a rigorous international research experience that will have a long term effect on their careers.

Fortunately, NNIN has access to a talented and proven pool of early career researchers, the “alumni” of the NNIN REU program, both who are quite capable of advanced research and who would benefit greatly from the additional research experience. The NNIN REU program is used as a feeder program to this more rigorous 2<sup>nd</sup> summer research program in an international situation, the NNIN iREU program. Because of their introductory NNIN REU experience and our rigorous selection process, our international partners can be confident the participants will be exceptional and contribute to their research at the level of graduate researchers.

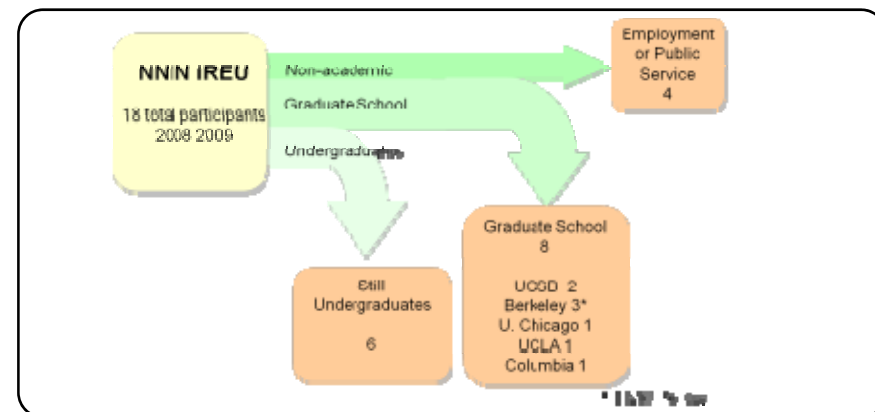
We recently completed the 2<sup>nd</sup> summer of this program, with 6 NNIN students at the National Institute of Materials Science in Tsukuba, Japan, and with 4 others at the Forshungszentrum Jülich in Germany. Our partners in Japan and Germany have been very impressed with the quality of participants and are eager to continue as partners with NNIN in this exciting program. We will continue with at least 10 more students in summer 2010. This program has demonstrated that even undergraduates with as little as one year of research experience can contribute to research at a leading international laboratory. The resulting “globally aware scientists” will contribute significantly to the next generation of nanotechnology researchers.



National Institute of Materials Science, Tsukuba, Japan



Forshungszentrum Jülich (Germany)



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# Nanotechnology Showcase for Students

## An NNIN Education/Diversity Program

Student awareness and excitement about nanotechnology is a prerequisite to a path that leads to appropriate education for a nanotechnology career. Many undergraduate institutions, however, do not have nanotechnology courses or research activities. Increasing student participation in nanotechnology thus requires new approaches to expose students to this exciting area.

The **Nanotechnology Showcase for Students** brings a nanotechnology exposition to conferences serving primarily undergraduate and minority student populations. The event, offered cooperatively by staff from all NNIN sites, consists of introductory lectures on nanotechnology and nanotechnology careers, followed by simple nanotechnology laboratory demonstrations. NNIN has a suite of portable nanotechnology instruments (AFM, STM, SEM, microscopes, spectrometers, etc) which can be brought to the conference site and quickly deployed to demonstrate key nanotechnology concepts. Staff from NNIN sites also demonstrate interesting nanotechnology applications drawing on activities in their laboratories.

To date, this event has been offered at the national conference and regional conferences of the Society of Hispanic Professional Engineers and the national conference of the National Society for Black Engineers. At each event, hundreds of students enthusiastically participated and went away with an expanded understanding of nanotechnology and their potential place in the nanotechnology world. The event also acts to promote participation in the NNIN REU program



### Nanotechnology Demonstrations & Activities

- AFM on Nanostructures
- STM of Graphene
- SEM of Familiar Microscale Objects
- Microfluidics
- MEMS
- Nanotechnology Products
- Shape Memory Alloys
- Optical Emission from Nanoparticles

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# International Winter School for Graduate Students

## *An activity of the NNIN Education and Outreach Program and the NNIN Program on Social and Ethical Issues in Nanotechnology*

The NNIN iWSG (International Winter School for Graduate Students) is a major new educational initiative for NNIN. The iWSG, a technical short course with a strong SEI component, is aimed at exposing a select group of graduate student users to education in a specific area of nanotechnology within the context of developing world environment. Each year, ten outstanding students are selected in a national competition. They participate in a one week technical short course lead by 6 US faculty. The course takes place in a developing country where they are joined by up to 100 foreign graduate students and faculty from a major international institution. The first iWSG was held in December 2008 at IIT-Kanpur (India) on the subject of organic electronics; The second will take place at IIT Bombay in Dec. 2009 on the subject of Nanoelectronics. Partnering arrangements are being pursued to bring future courses to other developing countries.

A critical and distinguishing part of the iWSG is that it endeavors to place the technology into the context of the developing world. During the 2<sup>nd</sup> week of the course, the group leaves the academic campus and travels to live and work in a rural village. In 2009, for example, they will be traveling to an off-grid village with little educational resources where they will be assisting in the construction of a regional school.

An NNIN faculty member in the area of Science and Society/ Social and Ethical Issues travels with the group. The SEI faculty plays a major role in this group as the students debate and wonder about of technology and technology's implications in the context of developing world. The intention is to help the students grasp not only the international nature of science and technology, but also the social context in which science and technology exist in most of the undeveloped world.



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# NanoExpress

## *An NNIN Education/Diversity Resource Operated by Howard University*

Introduced in the summer of 2006, the NanoExpress is a self-contained mobile laboratory operated by the Howard University Nanoscale Science and Engineering Facility (HNF). The NanoExpress presents the complex, fascinating world of nanotechnology to both students and the general public. With 208 sq. ft of lab space designed to facilitate hands-on experiments, it includes an AFM, an electron microscope, an evaporator, a small furnace, and photolithography equipment, enough to demonstrate a variety of nanoscale processes. Experimental activities include: Introduction to Passive Nanoparticles, Introduction to Self Assembly, Introduction to Micro and Nanofabrication, "Chips are for Kids", Instruments for Nanoscience, Shape Memory Alloys and Soft Lithography. Undergraduate and graduate students assist the staff in setting up and supervising experiments.

The NanoExpress maintains a full schedule of visits to elementary schools, middle schools, and high schools, as well as to national conferences and local civic events. The NanoExpress is also used by several advance level college courses. Most visits are in the DC regional area, although it has made trips to Massachusetts and Georgia. The NanoExpress incorporates green technology with a built-in biodiesel tank to for its diesel generator that supplies electrical power to the the equipment.

With NanoExpress NNIN can bring high technology to schools and communities that have very little exposure to nanotechnology or to advanced science in general. It is an important vehicle to bring understanding and awareness of science and scientific careers to these communities.



*The Nanoexpress is an activity of Howard University, as part of the Education Program of NNIN, the National Nanotechnology Infrastructure Network. Funded in part by the National Science Foundation as part of ECS-335765, Sandip Tiwari Cornell, PI*

# NNIN Laboratory Experience for Faculty

## *An NNIN Education/Diversity Program*

Assuring the diversity of the future nanotechnology workforce requires a multi-level approach. Students at minority serving institutions often have little exposure to nanotechnology and few role models within the faculty with nanotechnology research programs. Similarly, minority faculty may have interest in nanotechnology but do not have access to appropriate resources to start or continue a nanotechnology research program.

The NNIN Laboratory Experience for Faculty (LEF) provides an REU like experience to minority faculty and faculty at minority serving institutions. Faculty are selected from across the country and spend approximately 8 weeks at an NNIN site. In some cases, the faculty have nascent nanotechnology research programs but need access. In other cases, faculty have an interest in nanotechnology but do not have sufficient background or experience to properly integrate nanotechnology into their courses. As part of the program, selected faculty receive salary support, travel and housing, as well as access to NNIN facilities.

NNIN LEF was offered in the summer 2008 and 2009, with a total of 9 participants from 7 different institutions. Up to 5 participants will be selected for Summer 2010.

In the ideal case, LEF helps boost the research career of the participating faculty, leading him/her to become an NNIN user, 2) provides a nanotechnology context which can be integrated into his/her courses at the minority serving institution, and 3) develops an advocate for the NNIN REU program and thus improving the effectiveness of NNIN's REU recruitment efforts.



### **NNIN LEF Participants**

- Spelman College – Georgia Tech '08
- Norfolk State Univ.– Georgia Tech '09
- Univ. of Puerto Rico Maya. – Cornell '08 '09
- Shaw Univ. – Cornell '08
- Old Dominion Univ.– Cornell '09
- UT El Paso (2) – UT Austin '08
- San Jose State – Stanford '09

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