

A Nano Integration Program Success Story: Show me the benefits

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Nanotechnology Undergraduate Education at Lock Haven University

- Dr. Anura Goonewardene, Professor of **Physics**
- Dr. Jackie Whitling, Professor of **Chemistry**
- Dr. Amy Way, Professor of **Health Sciences**
- Dr. Marian Tzolov, Associate Professor of **Physics**
- Dr. Carina Howell, Associate Professor of **Biology**
- Dr. Indrajith Senevirathne, Assistant Professor of **Physics**
- Dr. Anamika Gopal, Assistant Professor of **Physics**
- Dr. Mike Cullin, Associate Professor of **Physics and Science Education**



Outline

- Vision
- Growing Resources and Incorporating Nanotechnology into all Sciences
- Student Research: a sample
- Grant proposal development
- Conclusion



Vision for Nanotechnology

- Incorporate the tools of Nanotechnology into Sciences (PACAN)
- Create interdisciplinary research opportunities
- Promote group work
- Students better tooled to take on the real world
- “Convergence Science” begun in 2005 at LHU
- Provide students with new tools and skills, and expand opportunities for them both as undergraduates and after graduation
- Student centered philosophy



Nanotechnology Resource Development: Grants & Collaborations

- LHU was the lead institution in the Pennsylvania Collaborative for Applied Nanotechnology (PACAN)
- As PACAN Coordinator from 2003 to 2008
Goonewardene led this seven University initiative
- Multiple grants from Pennsylvania Department of Community and Economic Development (PADCED) (\$800, 000 +)
- National Science Foundation (NSF) in 2008 and 2009 awarded grants totaling nearly \$700,000



Nanotechnology Resource Development: Facilities

- Penn State's Center for Nanotechnology Education and Utilization (CNEU)
- 18-credit summer experience at CNEU at PASSHE tuition rates.
- NSF funding SEM upgrade: EDX (Energy Dispersive X ray Analysis)
- Goonewardene planned the new Nano laboratories that include a class 100, 000 "teaching" cleanroom in Lock Haven's new \$30 million science center, scheduled for completion in 2013



Nanotechnology Resource Development: Curriculum and Faculty lines

- 2003- Applied Physics in Nanotechnology within the BS Physics
- 2005- AAS Degree in Nanotechnology Dual degree option
- Created a Director of Nanotechnology position (half-time release) to institutionalize the Nano program.
- Separate annual budgets for equipment and operations
- Two tenure track and a temp faculty lines added in physics to support Nano program.
- 2008- Minor in Nanotechnology
- 2011- Nanoscience Track in Chemistry



Nanotechnology Resource Development: Student Support

- NSF S-STEM grant 2008-2013 for need based scholarships, travel to conferences, guest speaker series, and pizza for weekly Nano Club meetings
- Student Activities fees support Nano Club

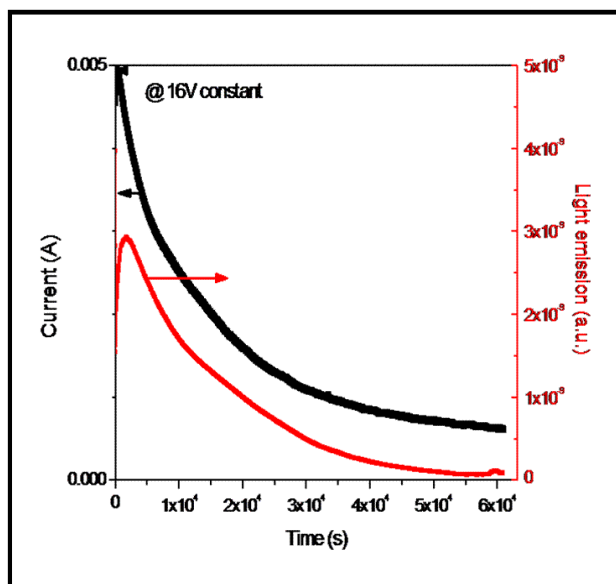


Nanotechnology Resource Development: Interdisciplinary student learning community and Faculty advisory group

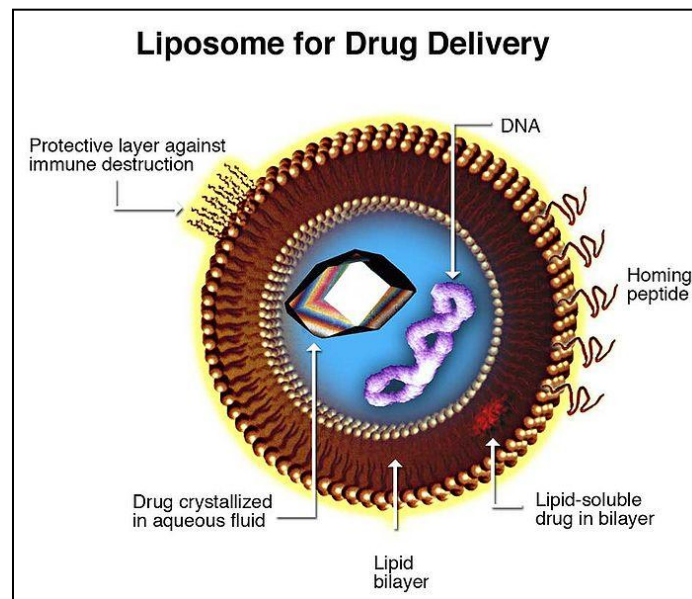
- The Nanotech Club, a student-run science learning community, helps with outreach and recruitment, tours industries, and hosts speakers
- We have 40 students in the program and about 30 attend the biweekly meetings of the Club
- Created the Nano Group comprising faculty members from every science department.
- Nano Group members mentor students in their respective disciplines and create and model collaborative research opportunities detailed in a manuscript by Goonewardene et al, accepted for publication (March 22nd, 2011) by the *Journal of College Science Teaching*
- In physics we have doubled our enrollments: LHU now has the 3rd largest physics graduation rate in PASSHE despite being the 3rd smallest school in overall enrollment, our approach is the subject of a Guest Editorial in *American Journal of Physics*, Goonewardene et al, accepted for publication (March 24th, 2011).



Student Research Sample: OLED, Targeted Drug Delivery

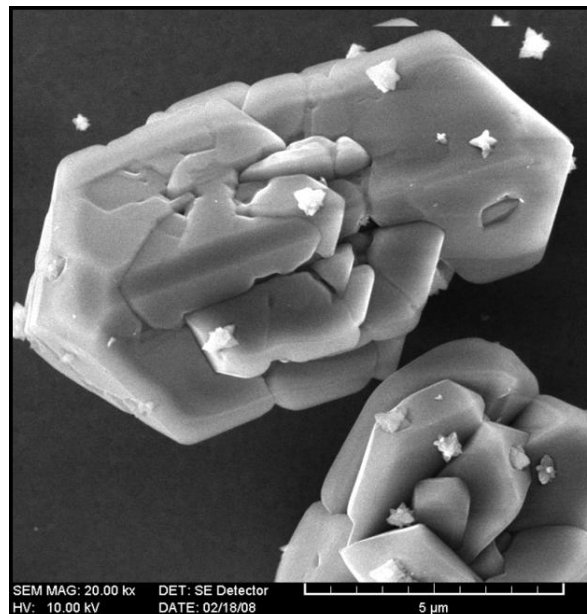
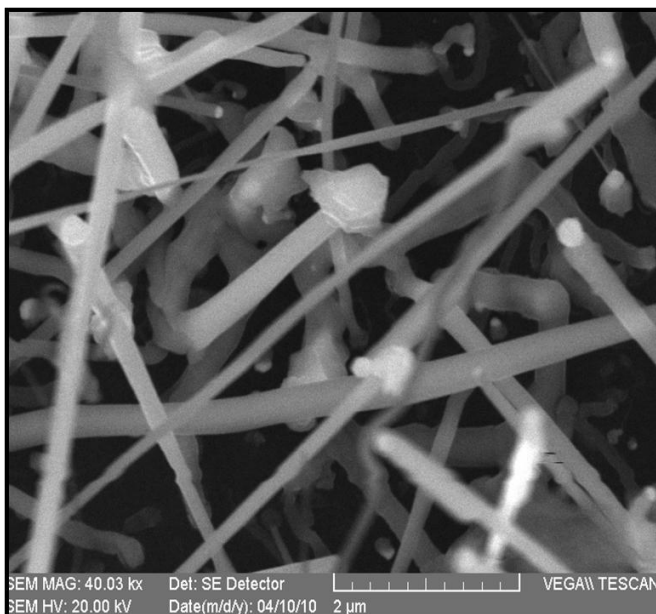


A stability test of a OLED device manufactured entirely at LHU by Dr. Tzolov and his students



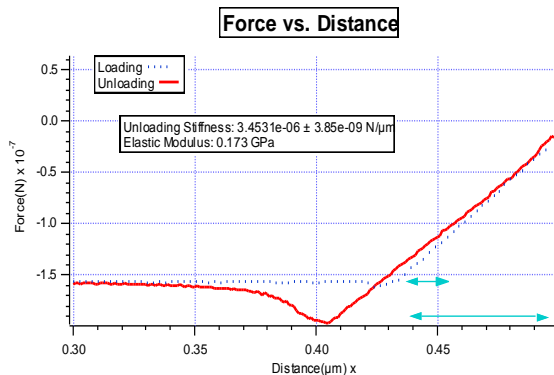
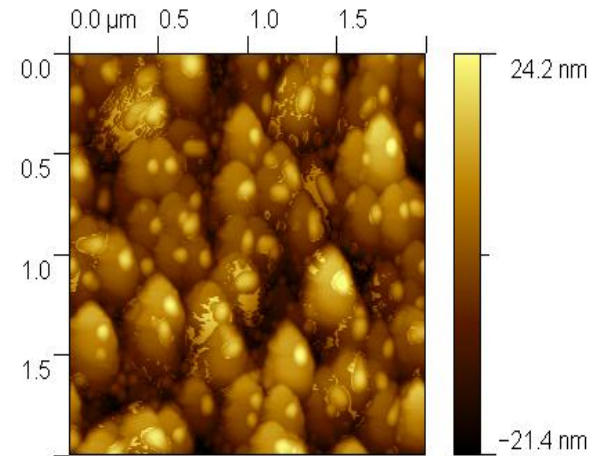
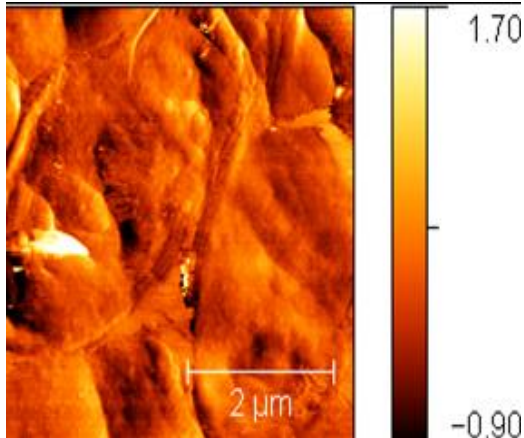
Model of a liposome for targeted drug delivery from nanopharmaceuticals.org Dr. Whitling and her students collaborate with Hershey Medical Center: Two internships generated

Student Research Sample: ZnO as drug scaffoldings and for organic photovoltaics



SEM images of ZnO synthesized by chemical vapor transport (left) and hydrothermal growth (right). Dr. Tzolov and Dr. Gopal work with students on ZnO prepared under different conditions to synthesize crystals for different applications from organic photovoltaics and drug scaffoldings

Student Research Sample: Fungi and self-assembly Ag on Si(100)



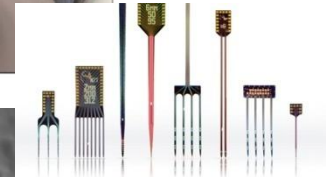
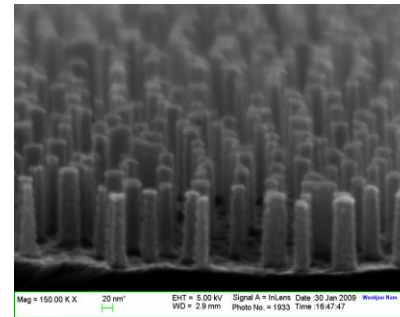
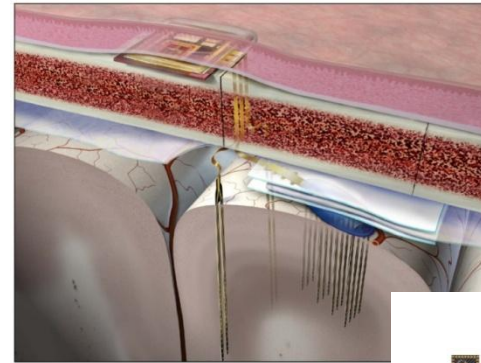
Left: AFM phase image of the *Phomopsis sp.* spore (fungi) and corresponding Force Curve to measure the cell wall hardness.

Right: AFM topography image of self-assembled Ag nanodots on Si(100) surface.

Dr. Senevirathne works with his students on Morphology and Mechanical Properties of Biological Structures and Noble Metallic Nanoparticles on Semiconductor Surfaces

Grant proposals under development: NSF Research at Undergraduate Institutions (RUI) program, Fall 2011

- Dr. Senevirathne won a Meritorious award of full time release to work with Dr. Stephen Fonash at PSU(NACK) on conductive biopolymers for neural interfacing in Fall 2010
- Will be implemented gradually at Lock Haven University as we develop facilities and equipment base (RUI)
- Goonewardene is leading an effort to develop an 4+1 articulation with the Department of Engineering Sciences and Mechanics that will also support the initiative



FESEM image of Conductive Polymer PEDOT Nanowires patterned on glass by Dr. Senevirathne and Dr. Stephen Fonash's group at PSU

Grant proposals under development: NSF Science Technology, Engineering, and Mathematics Talent Expansion (STEP) program, Summer 2011

- Pilot a 2+2 articulation with RACC
- Working with Penn State's Center for Nanotechnology Education and Utilization (CNEU) and their national Nanotechnology Applications and Career Knowledge (NACK) center (Dr. Stephen Fonash, Director) to develop a generic 2+3 program for any community college students who go through their Capstone Semester in Nanotechnology to earn a science degree
- Ask NSF for student scholarships to build path ways for the community college students to continue a program of study in the sciences



Affiliations

- Goonewardene created Articulations with Penn State University (2005) and the SUNY Upstate Medical School (2010) that provide pathways to MS/PhD programs in Engineering and Biomedical Sciences
- Five Applied Physics students have entered Graduate School at Penn State under the 2005 agreement. This number is instrumental in the 60% placement rate to graduate school enjoyed by the new Applied Physics (Nanotechnology) Track



Nano Graduates

Thirty seven graduates with 50% entering MS/PhD programs (most fully supported by assistantships)

50% of the students are in Engineering and Physics, while the other 50% are in Biology and Chemistry.

Graduate Programs

- Pennsylvania State University
- University of the Sciences in Philadelphia
- Bucknell University
- Drexel University
- University of New Mexico
- Georgia Tech
- University of Wyoming
- SUNY Upstate Medical School
- Ross University
- Drexel University
- City University of New York

Companies

- Dow Chemical Company (formerly Rohm & Haas)
- Tyco Electronics
- Advanced Cooling Technologies
- NanoHorizons
- Slack Pek, South Carolina
- Advanced Powder Products, Inc.
- Celgene/Life Bank, NJ
- Pfister Energy Corporation, NJ



Conclusion

- Nanotechnology is an inherently interdisciplinary field that attracts “nontraditional” students to science
- Innovative interdisciplinary programs can drive collaboration across disciplines and help small science programs grow
- Interdisciplinary collaborative undergraduate research engages students and promote group work
- Articulation agreements and developing pathways beyond graduation help attract quality students
- Convergence of life sciences with engineering and physics will demand better ways to teach students across disciplines
- Interdisciplinary programs in science can and must be developed to educate tomorrow’s workforce



References

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- Rise of "Convergence Science", *Inside Higher Ed*, Jan 05, 2011
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