Introduction to the Nanoworld Labs at the University of Cincinnati

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University of Cincinnati (UC), est 1819, students 43,000
Overview

• Nanoworld Labs (6): 413, 414, 507, 611 Rhodes Hall; 315, 581, 587 Engineering Research Center; Nanoworld Student Offices, 401 Rhodes Hall

• About twenty-five researchers from undergraduate to graduate students, faculty, and post doctors work in the Nanoworld Labs.

• About 35 people total at UC from the Colleges of Engineering, Arts & Sciences, and Medicine are involved in Nanoworld Projects.

• Nanoworld collaborates with researchers at other universities and government agencies including North Carolina A&T SU, Univ. of Pittsburgh, UT Dallas, CSIRO Au., Dalhousie Univ., the National Research Council Canada, the AFRL, NASA, ARO, ONR, and small companies such as General Nano, Odysseus Technologies, Interstellar Technologies, and others.

• Dr. Sergey Yarmolenko of North Carolina A&T State University and Dr. David Mast of UC Physics work closely with Nanoworld. Dr. John Yin is a project manager for the NSF ERC, Dr. Weifeng Li and Dr. Yi Song are post-doctoral scholars, and Dr. Noe Alvarez is a chemist and lab scientist all in Nanoworld. They help direct Nanoworld and co-advice students.
**NANOWORLD** is an interdisciplinary research and teaching lab in the college of engineering.

**NANOWORLD attained national and international prominence in the synthesis of nanoscale materials and integrating the materials into engineering and medical applications.**

The strategic goal of NANOWORLD is to integrate nanotech into university-wide curricula, to interest students to go to graduate school, and to develop new multifunctional materials, sensors, and smart materials, and to put these materials into applications.

Nanoworld supports graduate and undergraduate teaching and research and provides outreach by giving tours and workshops to middle and high school students and teachers.

Programs that NANOWORLD participates in are; Men in Engineering, Women in Engineering (high school student tours); Emerging Ethnic Engineers (undergraduate minority student tours); Ohio Space Grant, Graduate Summer Scholarships, Co-OP and Internships, Women in Science and Engineering WISE (UG and graduate research).

Students work on problems from nanotube in vivo sensors to detect cancer to designing new multifunctional materials including nanocomposites for advanced applications. A major area of research is to produce long nanotubes that can be spun into thread.

Nanoworld and UC spun off the company General Nano LLC in 2008 to commercialize carbon nanotube materials. A second company, Clinical Nano, may commercialize biomedical discoveries at UC (biodegradable implants, in vivo sensors/robots based on nanotechnology).
Facilities: Nanotube Reactors

**ET 1000**  
*2002*

**ET 3000**  
*2007*

**Black Magic**  
*2013*
Facilities: Robotics

Figure 3. Important plug-in tools used to make submicron CNT thread. Micromanipulator with: (a) normal probe; (b) force measurement system; (c) rotational tip; (d) low current measurement kit. The four arm robot nanomanipulator made by Kleindiek is able to manipulate and handle nanosize objects including carbon nanotubes. This manipulator system is a critical tool for characterizing nanotube fibers and providing feedback to the synthesis and modeling.

Figure 4. Kleindiek manipulator testing CNT fiber in a SEM, force versus time is measured.
Facilities: Spinning and Drawing
Figure 5. Test equipment; (a) Instron Micro Testing Machine Model 5948 with pneumatic, foot activated grippers and resolution of mN; (b) Four probe instrument Jander Engineering Unit RM 3000/MHP.

Also: Raman, SEM, Digital Optical
Thermal annealing of carbon nanotubes: (a) Ultra-high temperature furnace; (b) $I_g/I_d$ ratio from Raman spectroscopy of annealed CNT sheets as function of temperature and time. (Results by Aaron Johnson and Kumar Vemaganti)
Research Areas:

Materials Development

- Carbon Nanotube (CNT) Synthesis
- Spinning CNT yarn and drawing sheet
- Nanoparticles, coatings, functionalization

Applications

- Nanocomposite materials: High strength, Multifunctional
- Electromagnetics: Shielding, Wiring, Lightweight electric motor under development
- Intelligent Medical Devices: Controlled biodegradable Mg implants; Cancer screening; Magnesium implant development; Tiny machines, Biosensor electrodes
- Structural health monitoring: Composite materials
Nanoworld Education and Outreach

- Teaching UG and graduate courses
- Tours for high schools students
- Presentations and teaching at grade schools
- Training students for jobs that will be in high demand