NUE: Integrating Nanotechnology Education at CUNY Community Colleges

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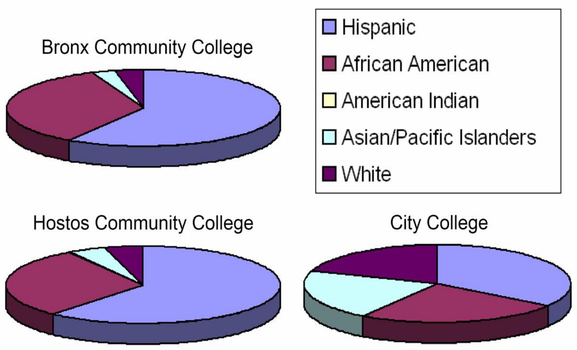
Educational Goals and Learning Outcomes

The proposal aims at integration of nanotechnology education at 2 of CUNY's two year Community Colleges (Bronx CC and Hostos CC) in a two-stage implementation process.

1. Evaluate/adjust CCNY material to appropriate level for BCC and Hostos CC students – also train faculty at both CCs.
2. Convert workshop to regular 3-credit course

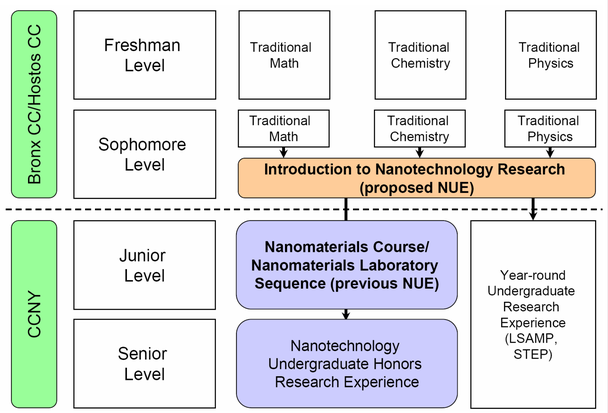


Collaboration between Bronx CC, Hostos CC and CCNY represents an opportunity to

(i) strongly impact minority students (Hispanic and African American students in the STEM disciplines at CCNY and more broadly in the nanotechnology sector

(ii) explore the potential for future research collaborations, and

(iii) create a pipeline for a diverse group of students from the 2-year CC programs into the 4-year program at CCNY



Educational Approach

Teaching Schedule for Course Sequence:

BCC

Spring 2011: *Introduction to Nanoscience Course* (experimental course, 10 students)
Fall 2011: *Introduction to Nanoscience Course* (experimental course, 6 students)

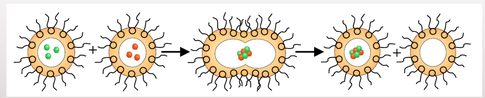
Hostos Community College

Spring 2011: *Nanoscience* integrated as nuggets to General Chemistry course (21 Students)
Fall 2011: *Introduction to Nanotechnology Course* (experimental course, 7 students)

Chemistry Module 1 – Synthesis of Nanoparticles

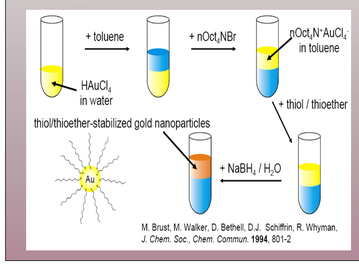
Objective: Learn to synthesize CdS quantum dots and gold nanoparticles.

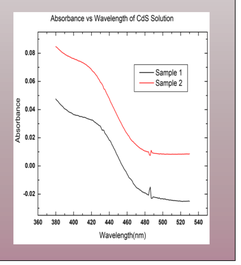
Task 1: Synthesize cadmium sulfide (CdS) quantum dots via reverse micelles.



Task 2: Synthesize gold nanoparticles according to Brust.

Task 3: Measure the absorbance spectra of the synthesized nano-particles and calculate their diameter.





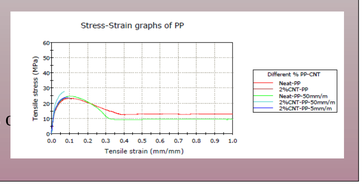
Mechanical Engineering Module 2 – Mechanical Properties of Nanoparticle/Polymer Composites

Objective: Be able to extract tensile data for polypropylene and CNT filled PP and operate the Instron testing machine.

Task 1: obtain the engineering stress-engineering strain curves for a nanocomposite and a plain polymer material under tensile loading.

Task 2: calculate modulus of elasticity (Young's Modulus), Yield Stress, Tensile Strength, ductility (percent elongation or percent area reduction), etc.

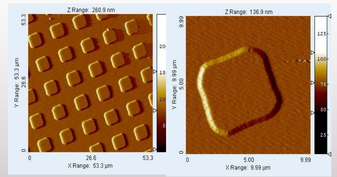
Task 3: determine the effects of [illegible] properties of polymers.



Topics Covered:

Lecture & Module 1: Introduction of Nanotechnology and Synthesis of Nanoparticles
Lecture & Module 2: Mechanical Properties of Nanoparticle/ Polymer Composites
Lecture & Module 3: Characterization of Nanomaterials
Lecture: Nanoscale Modeling and Industrial Relevance
Lecture/Survey: Ethical Consideration for Nanomaterials Research
Lab Course interdispersed: weeks 3 7-10, 2.5 hours, teams of 2-3 students

Chemical Engineering Module 3 – Imaging of Nanomaterials



Objective: Learn to use of atomic force microscopy (AFM) and observe scanning electron microscopy (SEM) for the imaging of nanomaterials.

Task 1: SEM demonstration
Task 1: Prepare samples for the AFM.
Task 2: Operate the AFM and image real samples.
Task 3: Interpret data obtained with the AFM.

Course Objectives:

After completing this course, students should:

- Be able to describe certain nano-phenomena;
- Be able to synthesize nanoparticles using chemical synthetic routes;
- Be able to operate UV/Vis spectrometer to follow the synthesis of nanoparticles and analyze the data;
- Be able to describe the 4 syntheses methods for carbon nanotubes;
- Be able to operate an atomic force microscope;
- Be able to understand the principles and benefits of using a Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscope and Scanning Tunneling Microscope;
- Be able to prepare samples for atomic force microscopy;
- Be able to analyze and interpret stress-strain data;
- Be familiar with ethical, environmental and health related issues associated with nanomaterials and their application.

Industrial Visitors:

(BCC/CCNY) Spring 2011
Dr. Patrick Spicer, P & G
Dr. Joseph Golba, PolyOne

Conferences (BCC)

Polym. Nanocomposites (PA) Spring 2011
ANTEC 2011 (MA)
Eurotec 2011 (Spain)

Outcomes[1]

Course Evaluation:

BCC Course Feedback Survey:

92% found the course useful, 50% consider a career involving nanotechnology, 67% have interest in undergraduate research, 42% would be willing to write a campus publication, 21% indicated interest in transferring to CCNY as a result of participating in the course, and 91% think nanotechnology is technology of the future.

Course Goal Assessment at BCC:

improvement on 15/19 questions in the general and specific knowledge category (improvement 2-50%).

CCNY Nanomaterials survey:

improvement on 15/17 questions, no change in one.

Suggestions for Future Implementation:

FULL course

- community college faculty needs a min. of 3 credit release time/semester
- elective course needs to count towards CC faculty teaching load;
- integrating nano as a nugget with Introductory Science courses will stimulate student's interest in nanoscience.
- tuition support for students ;
- CC faculty need to be provided with a specific example of insertion of nanotechnology into a particular classes

Broader Impact

BCC

- First course of its kind developed at a CUNY community college
- Close interactions between professors from different departments & different colleges
- Lowers barrier for implementation of the course and the laboratory

Total Student Enrollment for Introduction to Nanoscience Course :

Spring 2011 – 9 students completed the course, 1 was female and 8 male; 1 was Hispanic, 1African American, 5 African, 1 Korean, and 1 Caucasian; 3 students were from Chemistry, 5 from Engineering Science, 1 from Biology, and 1 from Nuclear Medicine.

Fall 2011 – 5 students will complete the course, 2 male and 3 femaile; 1 is Hispanic, 2 African American and 2 Caucasioan; 1 from Chemistry, 1 from Engineering, 1 from Biochemistry and 2 from Nuclear Medicine.

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References:

[1] "City College of New York Nanoscale Undergraduate Education – Preliminary Evaluation Report 2011", Elisabeth A. Palmer, Ph.D. ASPEN Associates, Inc.