

# INTRODUCTION

Website Publication on Computer Animations for Instruction on Nanomaterials

Visit: "<http://brahms.scs.uiuc.edu/lssr/software/nclt/>"  
Or: "[http://www.nanoed.org/concepts\\_apps/concepts.html](http://www.nanoed.org/concepts_apps/concepts.html)"

Interactive Computational Animations on Nanomaterials

Click here for "Overview and learning goals of the animations"

Click on each icon to view animations

- Cube Building**  
Required skills: None  
Class: Junior High Mathematics  
Related NCLT Unit Activity: Introduction to the nanoscale, surface area to volume ratio (Activity 1)  
Approximate Time: 20 min - 45 min  
Downloads: (Win) 1.03M; (Mac) 1.03M
- Superabsorbent Polymer**  
Required skills: High School Algebra and Geometry  
Class: High School Chemistry, AP Chemistry, College Chemistry  
Related NCLT Unit Activity: Introduction to the nanoscale, surface area to volume ratio (Activity 1)  
Approximate Time: 45 min - 1 hr  
Downloads: (Win) 2.07M; (Mac) 1.93M
- Gold Nanoparticles**  
Required skills: Ability to understand graphs  
Class: AP Physics, AP Chemistry, College Chemistry  
Related NCLT Unit Activity: Introduction to the nanoscale, Light Module  
Approximate Time: 1 - 2 hr  
Downloads: (Win) 2.03M; (Mac) 1.80M
- Photocatalytic Degradation of Methylene Blue by Titanium Dioxide**  
Required skills: Ability to understand graphs  
Class: AP Chemistry, College Chemistry, Engineering  
Related NCLT Unit Activity: Future nanotechnology unit  
Approximate Time: 1 - 2 hr  
Downloads: (Win) 2.00M; (Mac) 1.80M
- Photocatalysis Reactions of Titanium Dioxide**  
Required skills: High School Algebra and math conversion  
Class: AP Chemistry, College Chemistry  
Related NCLT Unit Activity: Future nanotechnology unit  
Approximate Time: 45 min - 1 hr
- Copper Nanowire Formation through Electrodeposition**  
Required skills: High School Algebra and math conversion  
Class: AP Chemistry, College Chemistry  
Related NCLT Unit Activity: Future nanotechnology unit  
Approximate Time: 45 min - 1 hr  
Downloads: (Win) 1.53M; (Mac) 1.27M
- Band Structure of Carbon Nanotube in Perpendicular Electric Field**  
Required skills: College Physics, Physical Chemistry  
Class: Nanotechnology, Electronics, Computational Electronics  
Related NCLT Unit Activity: Future Nanotechnology unit  
Approximate Time: 45 min - 1 hr

List of Authors/Contributors  
Contact: Lasse@UIUC  
December 2011

## Nanomaterials Design Projects

The Science Framework for the National Assessment of Educational Progress repeatedly stresses the importance of teaching "practical problem-solving that involves design, use of materials, and weighing risks in relation to benefits". (Also see "Project-based learning" by J. Krajcik & P. Blumenfeld in the Cambridge Handbook of the Learning Sciences, NY, 2005).

### Two design projects ideas are:

1. Design of biodegradable polymer micro and nanospheres
2. Design of passive cooling device with nanocomposite materials

# Interactive Educational Materials for Teaching "Nano" Concepts

Funding provided by:



The National Science Foundation

Presenter: Li May Goh (UIUC), Advisor: Prof. Richard Braatz (UIUC)

Main Collaborators: Valerie Maynard (Northwestern University), Mitsuko Fujiwara (Parkland College), Dan Reid (Champaign Central High School), Ramez Elgammal (University of Michigan), Umberto Ravaioli (UIUC)

NCLT  
Nanomaterials  
Work Circle



## ANIMATIONS DEVELOPED

**"Cube Building"** helps students learn the importance of surface area to volume ratio (SA/V) for nanoscale objects.  
Nano Concept: "As the object gets smaller, the SA/V becomes larger."

Students can build different size cubes. The program calculates the corresponding surface area (SA), volume (V), and SA/V.

**"Superabsorbent Polymer"** helps students learn about absorption and how surface area to volume ratio (SA/V) affects absorption rate.  
Nano Concept: "Smaller particles have higher SA/V and hence higher absorption rates."

There are quizzes and videos to reinforce students' understanding.

Students can plot to see how absorption rate changes with polymer size.

**"Gold Nanoparticles"** helps students learn about optical properties that are unique to the nanoscale.  
Nano Concept: "At the nanoscale, properties are different from the bulk properties."

Students learn that gold colloids have different colors depending on the particle size and presence of protein.

Students learn how gold nanoparticles are prepared.

**"Photocatalysis Reactions of TiO<sub>2</sub>"** helps students learn the mechanism of photocatalytic degradation of organic molecules by TiO<sub>2</sub> and UV light.

Students learn how wave energies can excite electron from the valance band to the conduction band in TiO<sub>2</sub>.

Students learn about the mechanism of photocatalysis.

**"Photocatalytic Degradation of Methylene Blue by TiO<sub>2</sub>"** helps students learn about the conditions that influence the photocatalytic degradation of organic molecules.  
Nano Concept: "Smaller particles of TiO<sub>2</sub> give higher photocatalytic rate."

Students can plot and compare reaction rates using different TiO<sub>2</sub> particle sizes.

Students learn about the experimental setup for the photocatalytic process.

**"Copper Nanowire Formation through Electrodeposition"** helps students learn about the formation of copper nanowires through electrodeposition.  
Nano Concept: "Illustration of an application of nano-sized technology in microelectronics industry."

Students learn about the formation of nanowires through electrodeposition (above) and an application of nanowires as interconnect (right: courtesy of IBM).

Students simulate trench filling by varying the horizontal: vertical ratio, surface and bulk diffusion rate, and incorporation rate.

## DESIGN PROJECTS

### Design of biodegradable polymer micro and nanospheres

Students will design size mixtures of biodegradable polymer micro and nanospheres to obtain a desired release profile for drug-delivery applications.

External Gelation

Curing alginate polymer in CaCl<sub>2</sub> (aq)

"Drug" release in sodium citrate solution

Dried

Initially

1 big bead 10 small beads

Undisturbed for 20 mins

Undisturbed for 40 mins

Undisturbed for 60 mins

Microspheres produced using emulsification/internal method

Next step is nanospheres

### Design of passive cooling device with nano-composite materials

Students will design the most effective device using different shapes and sizes of metals and moldable nanocomposite materials. Passive cooling devices have applications ranging from nano-devices to microelectronics

Examples of passive cooling devices

Cooling a CPU

Graphene-based Composite Materials  
Some composites made using graphite oxide and polystyrene (Courtesy of Ruoff et al., 2006).

### Preliminary experimental results for cooling a metal object

