

INTRODUCTION

Interactive Educational Materials for Teaching "Nano" Concepts

NCLT
Nanomaterials
Work Circle

ILLINOIS
STATE UNIVERSITY

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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 TiO₂" helps students learn the mechanism of photocatalytic degradation of organic molecules by TiO₂ and UV light.

Students learn how wave energies can excite electron from the valance band to the conduction band in TiO₂.

Students learn about the mechanism of photocatalysis.

"Photocatalytic Degradation of Methylene Blue by TiO₂" helps students learn about the conditions that influence the photocatalytic degradation of organic molecules.
Nano Concept: "Smaller particles of TiO₂ give higher photocatalytic rate."

Students can plot and compare reaction rates using different TiO₂ 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 CaCl₂ (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

Two sizes of dried spherical beads produced to compare diffusion and dissolution rate.

Microspheres produced using emulsification/internal method

Diameter less than 250 micron.

Next step is nanospheres

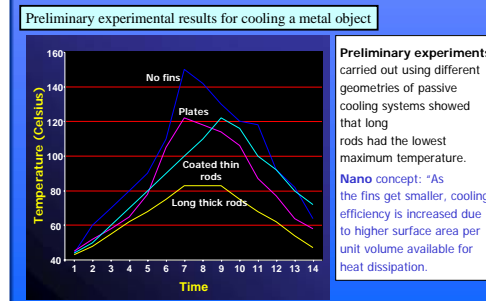
Design of passive cooling device with nano-composite materials

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).



Website Publication on Computer Animations for Instruction on Nanomaterials
Visit: "<http://brahms.scs.uiuc.edu/issr/software/nclt>"

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
Download for: (Win) | (Mac) | (Linux)
- 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 2)
Approximate Time: 45 min - 1 hr
Download for: (Win) | (Mac) | (Linux)
- 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
Download for: (Win) | (Mac) | (Linux)
- 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 environment unit
Approximate Time: 1 - 2 hr
Download for: (Win) | (Mac) | (Linux)
- Photocatalysis Reactions of Titanium Dioxide**
Required skills: High School Algebra and math conversion
Class: AP Chemistry, College Chemistry
Related NCLT Unit Activity: Future environment unit
Approximate Time: 45 min - 1 hr
Download for: (Win) | (Mac) | (Linux)
- Copper Nanowire Formation through Electrodeposition**
Required skills: High School Algebra and math conversion
Class: AP Chemistry, College Chemistry
Related NCLT Unit Activity: Future microelectronics unit
Approximate Time: 45 min - 1 hr
Download for: (Win) | (Mac) | (Linux)
- Band Structure of Carbon Nanotube in Perpendicular Electric Field**
Required skills: College Physics, General Chemistry
Class: Nanotechnology, Electronics, Computational Electronics
Related NCLT Unit Activity: Future Nanotechnology unit
Approximate Time: 45 min - 1 hr

List of Authors/Contributors
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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