Nanotechnology-Lessons To High School Students

NSF Reasearch Experiences for Teachers (RET)
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Organiztions: The Center for STEM Education (http://www.stem.neu.edu/)
The Research Experiences for Teachers (RET) (http://www.ret.neu.edu/)
Center for High-Rate Nanomanufacturing (http://www.nano.neu.edu/)
The George J. Kostas Facility for Micro and Nanofabrication (http://www.kostas.neu.edu/)

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Members of The Kostas Facility

Classroom Lesson Development

Title of Lesson **Nanotechnology**

RET Project Connection: Construction of two Nanodevices: Three Dimensional Nanoelectrode Connected via Silver (Ag) Nanoparticles and Electrohydrodynamic Micropumo

RET Teacher: Pakamas Tongcharoensirikul
School: Quincy High School
Town/District: Quincy
Subject(s) taught: Chemistry

Subjects covered in lesson: Scientific Notation, Size, Properties of Matter, Atomic Structure
Grades appropriate: 10-11
Lesson duration: Embed throughout the year

Goals/Objectives of lesson:
1. To connect students' understanding of different sizes
2. To familiarize students with using scientific notation in science
3. To connect atomic properties with nanoscale science
4. To connect students with nanoscale products and their properties

Background information: Properties of matter, scientific notation, atomic properties

Essential questions:
1. Size matter: Can I see? Optical microscope vs.Scanning Electron microscope (SEM)
2. It is so small: How many atoms of gold in one 40 nanometer gold nanoparticle?
3. Properties of the material change at the nanoscale: Is gold always yellow? How can that white sunscreen be clear?
4. Will my life be better with Nanotechnology?
   Of course.

Links to Frameworks and Standards

National

State: Massachusetts
Science and Technology/Engineering Curriculum Framework
October 2006
These lessons will fulfill the scientific inquiry dictated by the State of MA:
SIS1. Make observations, raise questions, and formulate hypotheses.
SIS2. Design and conduct scientific investigations.
SIS3. Analyze and interpret results of scientific investigations.
SIS4. Communicate and apply the results of scientific investigations.

Local: Same as state

Materials required:
1. Optical microscope
2. Picture of Scanning Electron Microscope
3. Nanodevices that I have made from the lab
4. Common chemicals for making iron oxide nanoparticles: NaOH, FeCl2, FeCl3, deionized water.

Lesson development

1. Lecture about properties of matter
2. Introduce object deposited with nanoparticles (from the lab)
3. Guide students to discuss what they can see and touch and what they cannot see but are there. Human eyes can see down to the range of micron (1X10ex-6 meter). Nanoscale science is in the range of 1-100 nanometer or 1X10ex-9 meter. Optical microscope, used for observing bacteria, cannot even observe nanoscale devices. Scientist must use scanning electron microscope.
4. Introduce students with conversion of units and scientific notation. It will be a lot of work if students cannot use the proper unit to call device in nanoscale or use proper scientific notation.
5. Conversion factor, units, scientific notation must be reminded throughout the year.
6. All devices, i.e. computer, electronics are moving toward nanoscale to increase efficiency,capacity and reduce space.
7. Is nanopod really a nanoscale device? Can it get smaller than present?
8. The devices that I made in the lab will be the basis for very, very small computers or devices to put in human body to probe the diseases.
9. Properties change with sizes. Gold is not always yellow. Gold-Nanoparitcles changes color with sizes. I can show this to the students.
10 How big is the atoms? I can ask students to calculate number of gold atoms in one 40 nanometer gold nanoparticle.
11. Throughout the year, I can talk about nanoparticles, nanodevices, nanomedicine and how they affect human's lives.
11. Full lab period-Making Iron oxide nanoparticles. This lab is not very complicated. Students will enjoy seeing chemical reaction in front of their eyes. Properties of chemical change and students can detect and observe.

Making Iron Oxide Nanoparticles

Supplies: Iron solution, Sodium Hydroxide solution (NaOH), transfer pipette, flask.

What is iron? What does iron have in common with gold?
What special properties does iron have?

Step 1:
Pour the NaOH solution into the flask.

Step 2:
Using a plastic transfer pipette, drop by drop add the iron solution to the NaOH solution while keep stirring the flask.

Record your observations:

Step 3:
After all of the iron solution has been added to the NaOH solution, - you now have iron oxide nanoparticles!

Do you think these nanoparticles are magnetic?

Step 4:
Wait for the particles to settle in the tube and use the bar magnet to determine if the particles are magnetic.

Record your observations:

Step 5:
Clean up.

Congratulations! You have now taken part in the NanoWorld!

References 1. http://www.doe.mass.edu/frameworks/scitech/1006.doc
2. http://nanosense.org/
3. Khanduja, N.; Selvarasah, S.; Chen, C-L.; DOkmeci, M.R. Applied Physics Letters, 2007, 90, 083105.