High School Nanotechnology Summer Camp Framework

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General Description

Audience:

This summer camp is designed for high school students (entering grades 10 to 12). No previous knowledge of nanoscience or nanotechnology is required.

Type of program:

This program describes a weeklong summer camp for high school students. The camp does not assume any previous knowledge of the field and thus is open to students from all backgrounds. It is hands-on; application based and also gives a broad overview to nanoscience/nanotechnology as a field with many career opportunities. Students are able to gain a comprehensive understanding through activities that introduce them to the unique properties at the nanoscale. Though lab-tours, discussion groups on societal and ethical implications of nanoscience/nanotechnology and an open-house at the conclusion of the camp where they present projects to families and friends, students are exposed to a wide variety of experiences.

Program Objectives

Learning Objectives: Overview of the various sessions is given below. The following 6 sessions cover a weeklong camp.

Session 1: Introduction to Nanotechnology: Size, Scale and Exploring Properties

- What is Nanoscience/Nanotechnology?
- The most efficient lab ever: NATURE
- Biomimetics

Session 2: Applications of Nanotechnology: Nanoscale Fabrication

- Engineering at the nanoscale

Session 3: Applications of Nanotechnology: Going Green

- Nanomaterials for Greentechnology

Session 4: Real World Nanotechnology: Lab and Industry Tours

Session 5: "Seeing Nano" and Nano in Everyday Life

- Seeing Nano: Tools
- Liquid Crystals

Session 6: Nano and Society

- Forum on Societal and Ethical Implications of Nanoscience and Technology

Session 7: Open House

NISE Network content map main ideas:

[x] 1. Nanometer-sized things are very small, and often behave differently than larger things do.

[x] 2. Scientists and engineers have formed the interdisciplinary field of nanotechnology by investigating properties and manipulating matter at the nanoscale.

[x] 3. Nanoscience, nanotechnology, and nanoengineering lead to new knowledge and innovations that weren't possible before.

[x] 4. Nanotechnologies have costs, risks, and benefits that affect our lives in ways we cannot always predict.

National Science Education Standards:

[ ] 1. Science as Inquiry
- [ ] K-4: Abilities necessary to do scientific inquiry
- [ ] K-4: Understanding about scientific inquiry
- [ ] 5-8: Abilities necessary to do scientific inquiry
- [ ] 5-8: Understanding about scientific inquiry
- [ ] 9-12: Abilities necessary to do scientific inquiry
- [ ] 9-12: Understanding about scientific inquiry

[ ] 2. Physical Science
- [ ] K-4: Properties of objects and materials
- [ ] K-4: Position and motion of objects
- [ ] K-4: Light, heat, electricity, and magnetism
- [ ] 5-8: Properties and changes of properties in matter
- [ ] 5-8: Motions and forces
- [ ] 5-8: Transfer of energy
- [x] 9-12: Structure of atoms
- [x] 9-12: Structure and properties of matter
- [x] 9-12: Chemical reactions
- [x] 9-12: Motions and force
- [x] 9-12: Conservation of energy and increase in disorder
- [x] 9-12: Interactions of energy and matter

[ ] 3. Life Science
- [ ] K-4: Characteristics of organisms
- [ ] K-4: Life cycles of organisms
- [ ] K-4: Organisms and environments
- [ ] 5-8: Structure and function in living systems
- [ ] 5-8: Reproduction and heredity
- [ ] 5-8: Regulation and behavior
- [ ] 5-8: Populations and ecosystems

[ ] 5-8: Diversity and adaptations of organisms
[ ] 9-12: The cell
[ ] 9-12: Molecular basis of heredity
[x] 9-12: Biological evolution
[ ] 9-12: Interdependence of organisms
[ ] 9-12: Matter, energy, and organization in living systems
[ ] 9-12: Behavior of organisms

[ ] 4. Earth and Space Science
[ ] K-4: Properties of earth materials
[ ] K-4: Objects in the sky
[ ] K-4: Changes in earth and sky
[ ] 5-8: Structure of the earth system
[ ] 5-8: Earth's history
[ ] 5-8: Earth in the solar system
[ ] 9-12: Energy in the earth system
[ ] 9-12: Geochemical cycles
[ ] 9-12: Origin and evolution of the earth system
[ ] 9-12: Origin and evolution of the universe

[ ] 5. Science and Technology
[ ] K-4: Abilities to distinguish between natural objects and objects made by humans
[ ] K-4: Abilities of technological design
[ ] K-4: Understanding about science and technology
[ ] 5-8: Abilities of technological design
[ ] 5-8: Understanding about science and technology
[x] 9-12: Abilities of technological design
[x] 9-12: Understanding about science and technology

[ ] 6. Personal and Social Perspectives
[ ] K-4: Personal health
[ ] K-4: Characteristics and changes in populations
[ ] K-4: Types of resources
[ ] K-4: Changes in environments
[ ] K-4: Science and technology in local challenges
[ ] 5-8: Personal health
[ ] 5-8: Populations, resources, and environments
[ ] 5-8: Natural hazards
[ ] 5-8: Risks and benefits
[ ] 5-8: Science and technology in society
[ ] 9-12: Personal and community health
[ ] 9-12: Population growth
[ ] 9-12: Natural resources
[x] 9-12: Environmental quality
[x] 9-12: Natural and human-induced hazards
[x] 9-12: Science and technology in local, national, and global challenges

[ ] 7. History and Nature of Science

- [ ] K-4: Science as a human endeavor
- [ ] 5-8: Science as a human endeavor
- [ ] 5-8: Nature of science
- [ ] 5-8: History of science
- [x] 9-12: Science as a human endeavor
- [x] 9-12: Nature of scientific knowledge
- [x] 9-12: Historical perspective

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Background Information

Definition of terms

Nano is the scientific term meaning one-billionth (1/1,000,000,000). It comes from a Greek word meaning "dwarf."

A nanometer is one one-billionth of a meter. One inch equals 25.4 million nanometers. A sheet of paper is about 100,000 nanometers thick. A human hair measures roughly 50,000 to 100,000 nanometers across. Your fingernails grow one nanometer every second.

(Other units can also be divided by one billion. A single blink of an eye is about one-billionth of a year. An eyeblink is to a year what a nanometer is to a yardstick.)

Nanoscale refers to measurements of 1-100 nanometers. A virus is about 70 nm long. A cell membrane is about 9 nm thick. Ten hydrogen atoms are about 1 nm.

At the nanoscale, many common materials exhibit unusual properties, such as remarkably lower resistance to electricity, or faster chemical reactions.

Nanotechnology is the manipulation of material at the nanoscale to take advantage of these properties. This often means working with individual molecules.

Nanoscience, nanoengineering and other such terms refer to those activities applied to the nanoscale. "Nano," by itself, is often used as short-hand to refer to any or all of these activities.

Program-specific background

This is a framework for a Nanotechnology camp for high school students. The activities are laid out for a camp that runs 5 consecutive days, from 10 AM to 4 PM. Students are not expected to have previous background in Nanotechnology before the camp. Some knowledge of science and math will help the students.

The camp curriculum designed for high school students has been successfully used for two consecutive years. This specific outline for the camp has been designed keeping in mind the connections of each topic to the next one. Thus the camp works best if used in the same sequence. If it is not possible to use the same sequence/use the entire outline, then shortening the overall framework by replacing activities with other shorter ones might work best rather than changing the order in which the material is presented.
Since it is focused at high school students wanting to learn about a new technology that could potentially benefit them as they start exploring career opportunities and college options, the camp is designed to demonstrate the interdisciplinary aspect of Nanotechnology/Nanoscience with other disciplines.

Please refer to either supplemental documents or additional links provided for individual longer activities. In some case, the short activities are explained in detail.
It is also recommended that educators devote time to background research; some references are suggested in supplemental documents. Some of the activities are suggested from the NISE catalog. However since the NISE catalog activities were developed for Informal Science institutions (primarily at middle school level), it is recommended that educators expand on these activities though content extensions more suited to high school students.

There are 7 sessions including the 'Open House' (on the last day of the camp). Note that a session is not exactly 1 day long. Some sessions are longer than 1 day and others last only half a day.

Important: On both Day 3 and Day 4, half of the day is used for lab tours. Please organize lab/industry tours in your region. If the tours incorporate the topics being covered in camp, the students are able to get a better idea of the application aspect of nanotechnology. If the organizers wish to incorporate more activities rather than lab tours, a good online resource is the University of Wisconsin, MRSEC-Nanolab:
http://mrsec.wisc.edu/Edetc/nanolab/index.html.

The following is a general list of materials. For a detailed list of chemicals, please refer to the individual activity.

Activities and Materials by Day

Day 1

Scale sorter game	Series of images from macro scale to nano scale	
	Laptop and Projector for playing video	
Properties that change with size	water (in squirt bottles)	
	glass beaker	
	small droppers for water	
	Clay or play dough	
	(Optional)micro pipettes with tips of different sizes	
Nasturtium Leaf	water	
	glass beaker	
	small dropper for water	
	Nasturtium Leaves	
	Dirt/dust or any fine grained dark colored powder	

	microscopes	
	glass slides	
Magic Sand	magic sand	
	Water	
	Large transparent beakers	
	Regular sand	
Superhydrophobic surfaces	Forceps	*Order chemicals ahead of time
	4 small beakers with 2-3 drops of food coloring	
	Glass slides	
	Squirt bottle with ethanol	
	Squirt bottles with Water	
	sandpaper	
	copper pieces	
	Aq. Silver Nitrate Solution 10 mM	2-3 students per station with each station set up with a medium beaker filled half way
	HDFT 1 mM in ethanol	2-3 students per station with each station set up with a medium beaker filled half way
	Silicon Oil	1 small beaker filled half way
	Plastic pipettes	
Butterfly wing	Wings	
	Acetone/ethanol in squirt bottle	
	petri dish or glass slide	
	Demo: Laptop and Projector	
Gecko foot	Sticky tape Suction cups	
	Magnets	
	Examples of a rough surface (tree bark, rock etc)	
	Examples of smooth surface (glass, metal sheet etc.)	
	Water in a squirt bottle	

	Paper napkins for clean up	

Day 2

Gecko Foot Day 2	Silicone RTV mold making kit	Depending on time, this activity can be done previous day, or the discussion can be covered on Day 1 and the activity on Day2
	Polycarbonate filters	
	Disposable weighing dishes	
	Glass stirrers	
	Balance (precision 0.01 gm)	
	double sided sticky tape	
	wide wood ice cream stick or plastic knife	
	double stick tape	
Photolithography	photo resist covered pcb (printed circuit board)	*Order chemicals ahead of time
	UV lamps	
	Seno universal Photo developer in 60ml bottles	Developer comes in either solid or liquid form. 2 students per station.
	Large and small beakers	
	Forceps/tweezers (heat resistant)	
	glass slides	
	150ml Ferric Chloride Etching liquid in glass beaker	The liquid should be above 80 deg C on hot plates. To make the etchant use 125 gm of solid to 4 Oz distilled water. 2 students per station.
	Hot plates (for above etchant)	
	plastic beakers for rinsing pcb	
	Photo resist stripper applicators	
	Multimeters	
	Gloves	

	Watch Glass	
Nanotubes	Balloons	
	Air pump/supply line for balloons	
	Hoop for assembling the setup	

Day 3:

Dye Sensitized Nano crystalline Solar Cell	FTO coated glass slides	*Order chemicals ahead of time
	TiO_2 nano particle paste	
	Ethanol (in squirt bottles)	
	Water (in squirt bottles)	
	beakers for rinsing	
	Hotplate	
	Heat resistant Tweezers	
	Plastic Petri dishes	
	Raspberry juice from 1 packet of frozen raspberries	
	Blue berry juice from 1 packet of frozen blue berries	
	Cheese cloth	For extracting juice from fruit, use one for each type of juice
	2 HB pencils	
	Multimeters	Can be shared among 3-4 students
	Iodide/triiodide	Can be shared
	binder clips	
	Projector (old fashioned transparency type)	
Gecko foot testing	Lego	
	Large glass slide	
	weigh baskets	
	twine	
	hooks	

	Balance (precision 0.01 gm)	
	double stick tape	

Day 4

Liquid Crystals	Cholesterly Oleyl Carbonate	You can have groups of 2-3 students for each composition of the Liquid Crystal; *Order chemicals ahead of time
	Cholestreyl Perlargonate	
	Cholesteryl Benzoate	
	Plastic sheet plain	
	Plastic sheet printed black squares	
	glass bottles	1 bottle per group of students
	Sticky tape	
	glass stirrer	
	Hot plate	
	Balance (precision 0.01 gm)	

Day 5

Societal and Ethical Implications Forum	Role playing handouts	This activity needs a moderator who can keep the discussion rolling
Open House for Family and Friends	Poster sheets	
	markers	
	Coloring pens and crayons	
	printer to connect to the laptop	
	laptop with internet	

Set Up

Time:

Follow the step-by-step explanation of how to prepare for each of the activities provided in the activity guides or lesson plans.

Program Delivery

Safety

Review specific safety precautions for each activity as written in the activity guides and/or lesson plans.

This camp is expected to be held in a Chemistry lab with all of the lab equipment such as fume hoods available.

Review safety information with the students before letting them work with the chemicals.

Students need gloves, glasses for most activities. They are required to be wearing at least capri length pants and covered shoes (standard Chemistry lab requirements). Contact lenses are not allowed in a chemistry lab.

Session 1: Introduction to Nanotechnology: Size, Scale and Exploring properties

Session length: 1.25 Days
The objective of the first half day is to talk about size, scale and properties at the nanoscale.

Main topics to be covered:

Introduction
Nanotechnology/Nanoscience: What, how and where did it all begin: Size and Scale, properties at the nanoscale.
The Nano Lab: Nature
Biomimicry: Learning from Nature

Talking Points, Program Delivery and Activities:

Begin the camp by introducing yourself, other instructors and assistants. Get all of the students to introduce themselves. A good ice-breaker introduction will ease the way for students to work together in groups. You can ask student to say something interesting along with their basic information (name, grade, school) such as: my favorite thing to do, or why I signed up for this camp etc.

1. *Discussion: What is Nanoscale? Why is it special? What interesting changes take place in properties at this scale?*

Size and Scale: (do not cover properties as yet)
-What is a nanometer?
-Units and conversion: meters, centimeters, millimeters, micrometers, nanometers and pico meters.
-What do the prefixes mean?

> **Activity:** Once they are familiar with the scale of things (meters to picometers) a great way to reinforce the idea of size and an excellent ice breaker is an **image sorting game**. Use 7-10 images from the macro scale to the nanoscale and ask the students to sort it by decreasing size. In order to use it as an ice breaker, divide up the students into two teams and let each team come up with their own solution.
> Once each team is done, the correct sort can be presented to the class as a whole. With high school students, the game can be made more challenging by using images that not well known and not having any makers on the image, i.e. students not only guess the size but they need to guess the object too. Use fewer macro scale images and more small scale images, a potential set of images are attached in additional documents.
> Resources from the NISE catalog: Exploring Size: Powers of Ten Game,
> Scale Ladder

The next activity is introducing why nanoscale is special and what nanotechnology is. The following video is a short but a great intro into this topic.

http://www.youtube.com/watch?v=eKj5lAmy9Wk

Good online resource:
http://nanosense.org/activities/sizematters/properties/SM_Lesson3Student.pdf

Surface Area:
Reactions take place at the surface of a chemical or material; the greater the surface for the same volume, the greater the reactivity. As particles get smaller their surface area to volume ratio increases dramatically. This increased reactivity for surface area to volume ratio is widely taken advantage of in nature, one biological example being the body's digestive system. Within the small intestine, there are millions of folds and subfolds that increase the surface area of the inner lining of the digestive tract. These folds allow more nutrients and chemicals to be absorbed at the same time, greatly increasing our body's efficiency and the rate at which we digest food.

> **Activity:** Cube problem and Clay (Play-doh): Define surface area and volume. Let students calculate surface area and volume of a simple cube with 1 inch sides. Ask them to break the cube into 4 cubes and then recalculate both volume and surface area. Next the simple cube is divided into 8 cubes and then 16 cubes. Each time have students calculate both volume and surface area. Talk about how the volume does not change but the surface area increases, also talk about the non-linear increase in surface area as the cube is split.
> Resources from NISE catalog: http://www.nisenet.org/catalog/programs/cutting-it-down,
> http://www.nisenet.org/browse/catalog/results/surface%20area%20cart%20demo

Reactivity: Alka Seltzer
One result of an increase in the surface area is in reactivity. The use of Aluminum in bulk and its spontaneous combustion at the nanoscale is a good example. Using Alka-Seltzer, it can be shown how the reaction rate is faster when it is broken into very small pieces.

> **Activity: Exploring Properties: Surface Area**
> http://www.nisenet.org/catalog/programs/exploring_properties_-_surface_area_nanodays_08_09_10

One prime example of surface area to volume ratio at the nanoscale is gold as a nanoparticle. At the macroscale, gold is an inert element, meaning it does not react with many chemicals, whereas at the nanoscale, gold nanoparticles become extremely reactive and can be used as catalysts to speed up reactions.

Color: Optics and microscopes
A brief introduction to light waves, wavelength can be given here. Explaining why it is not possible to use light microscopes at the nanoscale serves as a good introduction to the butterfly wing activity that will be done later in the day.

2. *Let us look at these properties further. Through the day today we will explore some of these properties in more detail and will also look into how nature has solved some related problems. Biomimicry or Biomimetics means emulating nature. In this field of research, scientists study how nature has solved complex engineering problems and emulate it to find*

solutions for real world issues. Biomimetics is a critical component in Nanotechnology, since nature works at a very small scale, in a lot of cases at the nanoscale. Today we will look at a few examples of biomimetics in nanotechnology.

Surface Tension and Water:

Phenomenon: Explain surface tension; explain forces that at act as the water droplet gets smaller (explore shape of a water droplet on a surface using micro pipettes). What are hydrophobic and hydrophillic surfaces? How does a surface affect the shape of a water drop? How is hydrophobic surface different from super-hydrophobic surface? (contact angle between the surface and the water drop); water drop on a waxy paper, water drop on a glass slide dipped in silicon oil.

Activity**:** Exploring Forces: Gravity
http://www.nisenet.org/catalog/programs/exploring-forces

In Nature:

Activity: Lotus leaf effect:
http://www.nisenet.org/catalog/programs/lotus_leaf_effectuse nasturtium leaf to the students to explore the effect, shape of water droplets and the self cleaning ability of the leaves.

In a Lab

Activity**:** Water Race: Hydrophobic Surfaces and Hydrophillic Surfaces
(http://www.nisenet.org/catalog/programs/nnin_-_water_race_hydrophobic_hydrophilic_surfaces)

Activity:
Magic Sand/ NanoSurfaces
http://www.nisenet.org/catalog/programs/magic_sand_nanosurfaces
Sand, Plants and Pants
http://www.nisenet.org/catalog/programs/sand_plants_pants
Applications of superhydrophobic surfaces

Video on Superhydrophobic surfaces: http://www.youtube.com/watch?v=berp-odsKFo&feature=related

Color and Light:

Let us look at Color and Optics and how Nature has mastered the art of manipulating light at the nanoscale.

Give a brief introduction to light, wavelength and color (visible wavelength and invisible wavelengths).
Interaction of light and matter: Reflection, refraction and interference
Thin film interference and Bragg diffraction
Photonic crystals in nature, biomimicry and applications

Activities: Artificial Opals Activity,
Exploring Products: Sun block
(http://www.nisenet.org/catalog/programs/exploring_products_-_sunblock_nanodays_2011),
Nanoparticle stained glass
(http://www.nisenet.org/catalog/programs/nanoparticle_stained_glass_cart_program)
Thin Films: http://www.nisenet.org/catalog/programs/exploring_materials_-_thin_films_nanodays_2011

Good online resource: http://nanosense.org/activities/clearsunscreen/index.html

Forces at the nanoscale:
At the nanoscale, the effect of gravity is negligible. Electromagnetic forces and other intermolecular forces become prominent due to the small size and mass of objects. A unique manifestation of this can be seen in Geckos. Geckos are very well known for their ability to climb almost all surfaces. Recent research has shown that this ability is due to the nanosize hairs in the toes of the Gecko and the forces acting between the hair and the surface that Gecko is on.

Activity**:** Biomimicry: Synthetic Gecko Tape through Nanomolding
(http://www.nisenet.org/catalog/programs/biomimicry_synthetic_gecko_tape_through_nanomolding)
http://www.nisenet.org/catalog/programs/exploring_forces_-_static_electricity_nanodays_11
Also talk about applications of gecko tape

Session 2: Applications of Nanotechnology: Nanoscale fabrication

Session length: 0.75 Days

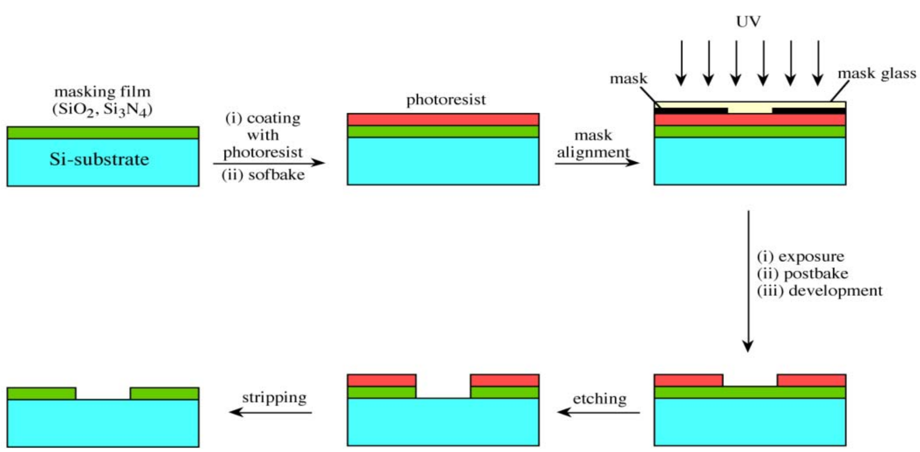
This session explores an important application of nanotechnology: nanoscale fabrication. Nanoscale fabrication is used in almost all electronics today, from TV's to cell phones to computers. The small size manufacturing comes with its own challenges of contamination, increasing resistivity with surface area, tools and techniques that are needed for consistent manufacturing results. Lithography is a good segue from the previous session which ends with making the Gecko tape. The technique used for making the tape is sometimes called soft-lithography. The term lithography literally means 'litho'-stone, 'graphy'-writing.

Note: It is likely that on Day 1, only the Gecko foot discussion is covered and the making of the gecko tape be postponed to the beginning of Day 2 due to time constraints. Thus Session 2 may start mid-morning of Day 2.

Main activities to be covered:
Photolithography
Intro to Nanostructures
Making the Balloon Carbon Nanotube

Talking Points and Program Delivery

Photolithography:
--Use the NISE catalog activity Photolithography
--Top down and bottom up approach to manufacturing
--A great video on computer chip manufacturing:
http://www.youtube.com/watch?v=aWVywhzuHnQ&feature=related
-- Various types of lithography and limitations of photolithography
--electron beam lithography and focused ion beam lithography



Nanotubes, Nanowires and Other Nanostructures:

--Introduce basic bonding concepts, graphite and diamond
--History of carbon nanotube, structure and properties
--Modeling a nanotube, use a printed transparency of a graphene sheet to demo.
--The indigo molecular ball and stick model of the nanotubes is very useful.
--Aspect ratio in nanotubes: effect on electronic properties
--Other applications
--Images from NISE NET of nanotubes (http://www.nisenet.org/viz_lab/image-collection)
--Metal Nanotubes and Nanowires of other materials
-- Quantum dots and applications in medical imaging and computing
--Synthesis of nanoparticles (Can include the gold nanoparticle synthesis activity as a demo http://mrsec.wisc.edu/Edetc/nanolab/gold/index.html)
Good videos: http://www.azonano.com/nanotechnology-video-details.aspx?VidID=307
http://www.youtube.com/watch?v=GiIllbIwoBI

Activity: Balloon Nanotubes Giant Hanging Model
http://www.nisenet.org/catalog/programs/balloon_nanotubes_giant_hanging_model

This is a great activity for the class to do at the end of the day. It not only helps in understanding the structure of a nanotube, but can be used as a tool for informal discussion on nanotubes.

Session 3: Applications of Nanotechnology: Going Green

Session length: 0.5 Days

This session covers the importance and overlap of nanotechnology (primarily nanomaterials) to green technology.

Talking Points and Program Delivery

Resource for discussion:
http://www.nanotechproject.org/file_download/files/GreenNano_PEN8.pdf

> **Activity:** Dye Sensitized Solar Cells:
> http://www.nisenet.org/catalog/programs/dye_sensitized_raspberry_juice_solar_cell

--Other nanotechnology based photovoltaics
--Organic Light Emitting Diodes
--Nanostructures based high efficiency lighting systems
--Applications of nanomaterials in wind and hydro power generation (turbine blades etc.)

Session 4: Real World Nanotechnology: Lab and Industry Tours

Session length: 1 Day

In the tested framework, this daylong session is on lab and industry tours. Students visit various research labs on campus at The University of California, Berkeley for half a day. The other half day, they visit Lawrence Berkeley National Laboratory.

One important component of the lab tours is to see the tools used by the researchers (AFM, FIB, SEM etc). Students also image some samples using a Hitachi Table Top SEM (TM-1000) at the campus Electron Microscope Laboratory. These SEM's are relatively inexpensive and are very easy for students to use. They also get to see what a clean room looks like and its importance in nanofabrication. The labs for the tours are selected based on the research ongoing in them, and topics are chosen so that students are exposed to the lab and application aspects of the topics being covered in class. It is good idea to have graduate and undergraduate students in the labs take the camp students on the tours so that they are able to interact better with them.

In order to find labs for tours, it is a good idea to look at the nearest University or National Lab. Though it is possible to contact faculty for this, it works better if you call the administration assistants of faculty or education and outreach coordinators of the labs (MRSEC and NSEC's) and for the National labs.

You can use the 'find a scientist link' through NISE here to find a scientist to partner with near your institution. http://www.nisenet.org/community/find-a-scientist.

Session 5: "Seeing Nano" and Nano in Everyday Life

Session length: 0.5 Day
In this session we look at a very active field of research 'probing the nanoscale'. Probing at the nanoscale covers more than just imaging, it deals with improving the capability to observe, manipulate, and control nanoscale objects and phenomena.
The second half of the session covers an example of Nanotechnology that we are using everyday. Liquid Crystals and displays based on LC have become an integral aspect of the consumer life. The working of LC is at the macroscopic level is controlled by manipulating the molecules at the nanoscale.

Main Activities:
Probing the Nanoscale: Probe Microscopes and Electron Microscopes
Liquid Crystals

Talking Points and Program Delivery

Probing the Nanoscale: Probe Microscopes and Electron Microscopes
--Difference between probe microscopes and electron microscopes
-- Advantages of electron microscopes over light microscopy
--TEM, SEM
--Limitations of electron microscopy
--Probe microscopy-data accumulation and imaging
--SPM, AFM, STM
--AFM model (if you do not have one, reference articles are attached in supplemental documents "measurement and resolution in AFM" and "LEGO AFM")

Activity: Exploring Tools: Special Microscopes
http://www.nisenet.org/catalog/programs/exploring_tools_-_special_microscopes_nanodays_08_09_10_11

Liquid Crystals (LC):
--Theory and working of LC (http://www.personal.kent.edu/~mgu/LCD/home.htm)
--LC display and its working

Activities: Synthesizing Liquid Crystals:
http://www.nisenet.org/catalog/programs/liquid_crystals
Exploring Materials: Liquid Crystals (take home)
http://www.nisenet.org/catalog/programs/exploring_materials_-_liquid_crystals_nanodays_08_09_10

Session 6: Nano and the Society

Session length: 0.5 Day

The Cognitive Enhancement Teen Role Play Forum (CETF) is a great way to get teens to explore the risks and benefits of nanotechnology. In terms of technical knowledge, this program is fairly light and approachable. In this forum participants use role playing as a means to explore societal and ethical implications of nanotechnology on a topic they'll readily identify with: academic performance. The program can last from a half hour to 2 hours.

Session 7: Last Day Open House

Session length: 0.5 day

Open house is great way to give the students an experience of a poster session. It also serves the purpose of reviewing all the materials that was covered in camp. In this camp, we divide the students in groups of 2-3 students and ask them to pick their favorite topic from the camp. They then spend an hour making their poster. They have access to a printer and internet so that they can look up information and print out images.

The open house is open to all family and friends of the students. We invite staff as well as the people who help with the camp (faculty from labs, grad and undergrad students giving lab tours etc.)

It serves as great wrap up for the 5 day long Nano camp.

Tips and troubleshooting

Read up on the theory and background! The framework has suggested topics to be covered for each activity, in some cases good resources have been recommended but full lectures have not been included.

If you want to shorten the camp, it may be more effective to cover some from each session rather than skip an entire session.

Try out all the different labs ahead of time, some of them are very time critical. The materials required need to be ordered ahead of time, in some cases it may take upto a month to be delivered.

Logistics is very important, plan on having enough time to arrange for lab tours, ordering materials and getting things ready. It works better if you have some guests for some of the lectures. Graduate students working in that field or post docs are a great choice. Not only does it break the monotony of listening to the same speaker (for the students!) but grad students and post docs in the field are able to give insight about working in the lab and getting research positions that is invaluable.

Lastly, have enough time for the students to get to know each other; it is important they feel comfortable asking questions. High school students easily take 1-2 days to do it!

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