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Manipulation of Light in the Nanoworld

NCLT

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Approach

Pedagogy
(Anchoring an idea in the world of the students)

The **macro** world of students' awareness → The **nano** world that can affect their lives

Concepts
(Linking known concepts applied at the nanoscale)

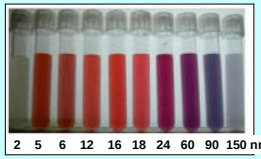
Big Nano Idea

Size and Structure determine the Nature of the Interaction between Light and Matter.

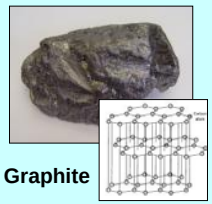
Gold in Macro and Nano Sizes

Gold Bar

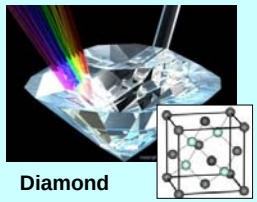
Different Sizes of Colloidal Gold Particles



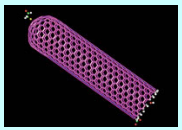
Carbon in Macro and Nano Forms



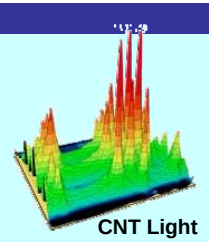
Graphite



Diamond



Carbon Nanotube (CNT)



CNT Light Emission Intensity

Macro Light Sources

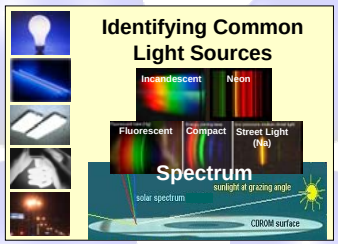
Light may be produced by thermal emission and/or energy excitation

Relevant HS Topics:
- Sources of Light
- Nature of Light
- Spectroscope

Splitting Light Using a CD

Homemade CD Spectroscope

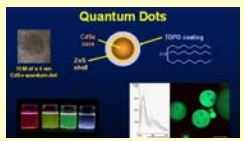
Identifying Common Light Sources



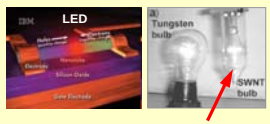
Nano Light Sources

Nanoscale Phenomena

Quantum Dots



Carbon Nanotube Lights



CNT Light Bulb

Advantages

Nano Light Source
- high efficiency
- designer color

VS.

Macro Light Source
- low efficiency
- limited color

Interference

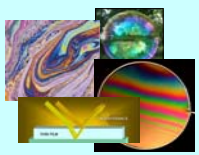
All waves exhibit interference, combining constructively or destructively

Relevant HS Topics:
Wave Phenomena:
- Acoustic
- Optics

Mechanical Waves in a Ripple Tank

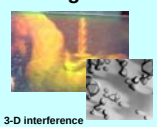
Light as Waves (Young's Experiment)

Thin Film Interference: Soap/Oil Films



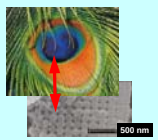
Interference by Nanoscale Structures

Hologram



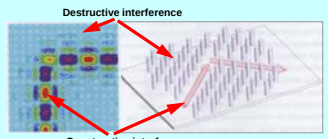
3-D interference pattern recorded by nanocrystalline silver halide particles embedded in holographic film.

Peacock Feather



Structural colors result from 2-D interference on peacock feather's nanocrystalline surface structure.

Manipulation of Light in Photonic Nano Crystal



Diffraction

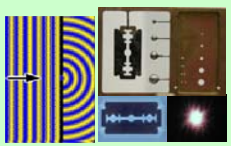
Waves tend to bend when they pass through an opening or around an obstacle

Relevant HS Topics:
Wave Phenomena:
- Acoustic
- Optics

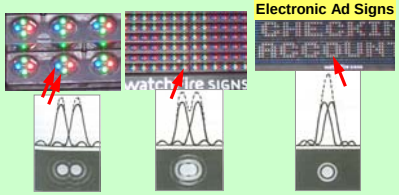
Hearing Around Corners

Water Waves Bending Around Rocks

Light Wave Diffraction by Razor & Pinholes (opening ≈ λ)

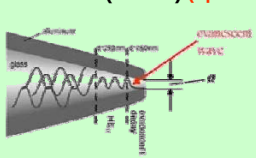


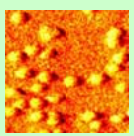
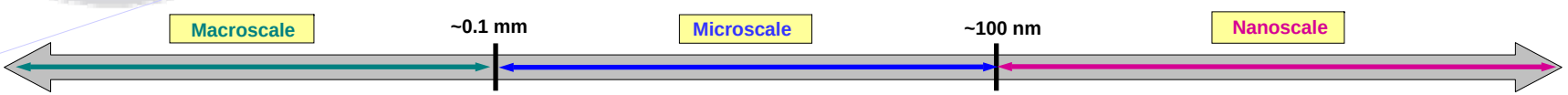
Light Diffraction through Eye's Pupil



Breaking the Diffraction Limit

Near-Field Scanning Optical Microscope (NSOM) (opening << λ)





Optical image obtained from gold nanoparticles (~50 nm).