Gold Nanoparticles

Background Information Slides

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Nanoparticles

- Nanoparticle is a particle 1nm – 100nm in size
- The simplest nanomaterial
  - Several atoms in size and larger
- May be human-made…
  - Metal nanoparticles
  - Semiconductor materials
  - Ceramics: ZnO, SnO_2, Al_2O_3
  - Carbon (C_{60})
- Or found naturally
  - Carbon and organics
  - Sulfates, nitrates (atmospheric)

Nanoparticles

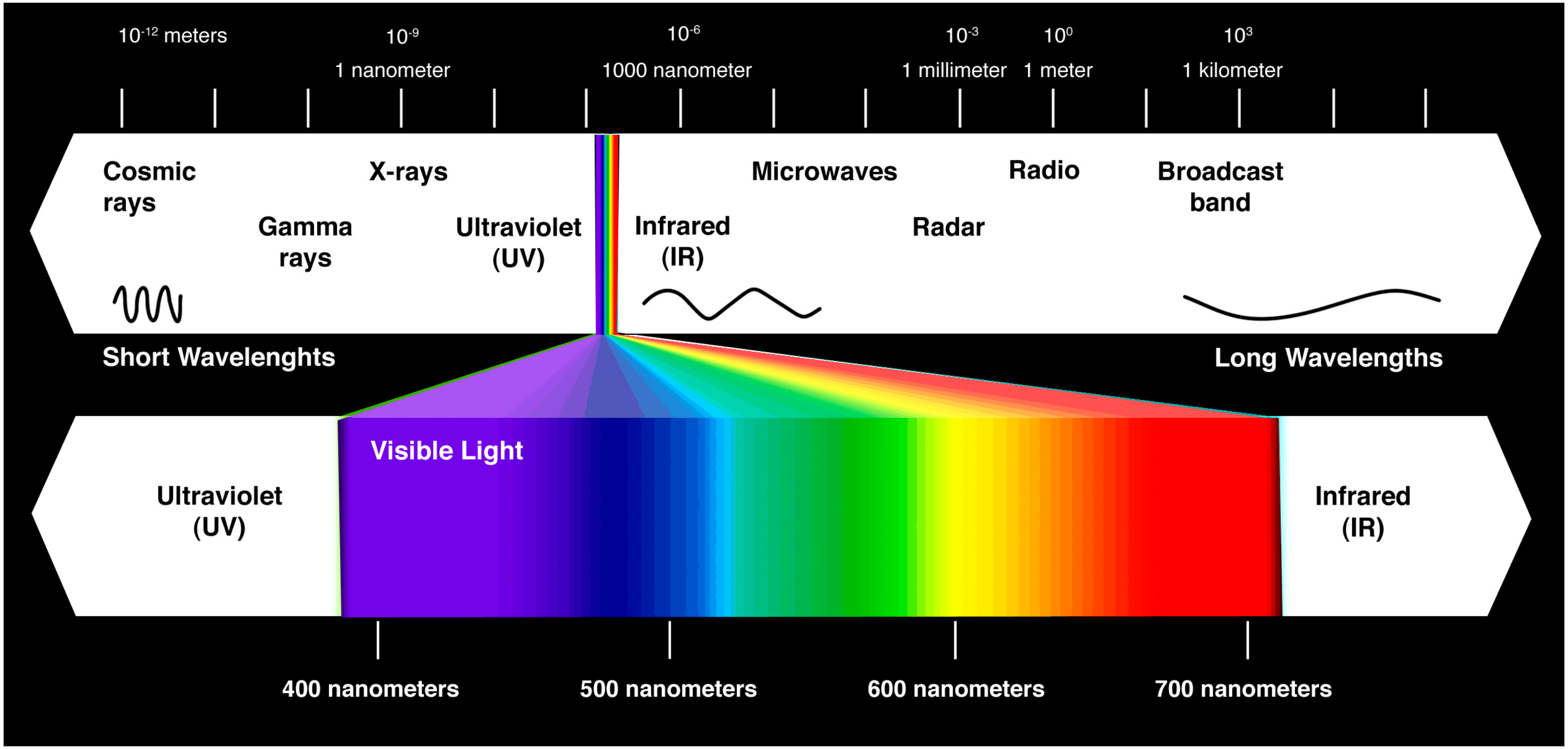
Nanoparticles are interesting because

- Most of their atoms are on the surface: maximizing reactivity
- They are smaller than the *critical length* of many processes, changing their properties
- Nanoparticle colors can be “tuned” by changing particle size, shape, or composition
- Originally used as a method of staining glass in ancient times

Uses for Nanoparticles

- **Dispersions** (inks, paints, drugs, cosmetics)
- **Colloidal chemistry** (molecules to particles)
- **Plastics**
- **Coatings and composites**
- **Stained glass**
    - Changing the size, shape or composition changes the color
    - Changing the size, shape or composition is much cheaper than creating a new chemical formula

The Visible Light Spectrum



Why We See Colors

When light strikes an object, that light may be

- Scattered
  - Light that is scattered (bounced off) the particle is observed by the human eye as the same color that is scattered – red is scattered so we see red
- Absorbed
  - Light is absorbed into the particle and the human eye see's the color that is transmitted (not absorbed) – blue and green absorbed so we see red
- Reflected polychromically
  - Light is absorbed and scattered, and we see multiple colors based on our angle of observation

The particle size, shape, and composition will determine what wavelengths will be absorbed, scattered or both

Making Nanoparticles

Colloidal gold, or “nanogold”, is a suspension of sub-micron particles of gold in a fluid

- Dissolve chloroauric acid (H[AuCl4]) in distilled water, Rapidly stir the solution while adding in a reducing agent (1% trisodium citrate)
- Continue to stir until the solutions becomes a deep red color (red wine)
- Au+3 ions are reduced to neutral Au atoms
- Atoms come together to create larger particles

Making Nanoparticles

Colloidal nanoparticles must be *stabilized* against agglomeration to stay a suspension

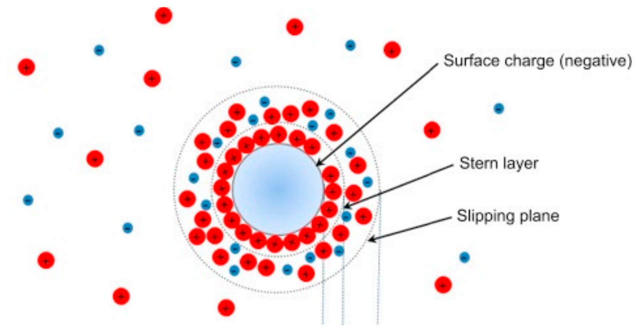
- If suspended nanoparticles impact each other, close range forces will cause them to adhere.
- The particles will agglomerate and eventually grow heavy enough to settle under gravity. The dispersion is said to be *unstable.*

Stabilizing Nanoparticles

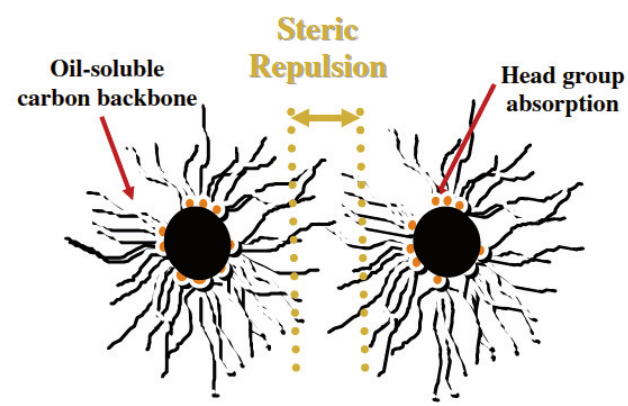
Nanoparticle dispersions can be stabilized by

- Applying an electrostatic charge to the particles' surfaces. Since like charges repel, the particles will not get close enough to stick together.

- Coating the particles with long organic molecules. This coating interferes with particles approaching each other, preventing sticking. This is called *steric stabilization.*



Ions surrounding a charged nanoparticle



Steric stabilization of a nanoparticle

Images: Research Gate, ScienceDirect.com