

# Nanotechnology: What's All the Buzz About

**Nanotechnology is the science and technology of small things** – in particular things that are less than 100nm in size. One nanometer is  $10^{-9}$  or one billionth of a meter. Scientists have discovered that materials at small dimensions-small particles, thin films, etc., can have significantly different properties than the same materials at larger scale. There are endless possibilities for improved devices, structures, and materials if we can understand these differences, and learn how to control materials and structures at the nanoscale. There are different views of what is included in nanotechnology but most agree that three things are important: 1) Small size – 1 to 100 nanometers or less, 2) Unique properties because of the small size, and 3) Ability to control the structure and composition in order to control these properties.

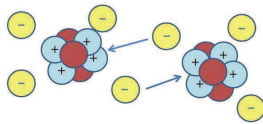
## Examples of How Properties Change at the Nanoscale

**Optical Properties:** Bulk gold appears yellow in color- Nanosized gold appears as different colors depending on particle size. Many other materials behave similarly. The ability to change the optical properties of materials is a powerful tool in the development of nanotechnology products

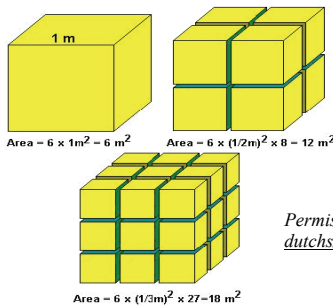


Douma, M., curator. (2008). Gold. In Cause of Color. Retrieved 1/30/2012, <http://www.webexhibits.org/causesofcolor/3.html>.

**Forces:** gravitational forces become negligible and electromagnetic forces dominate.



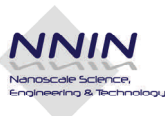
**Surface Area to Volume Ratio:** For smaller particles, a greater proportion of material is exposed on the surface. This becomes even more important in the nanoscale, where a large fraction of the atoms become “surface atoms” where they are more accessible to chemical reactions



Permission granted by S. Dutch; <http://www.uwgb.edu/dutchs/EarthSC202Notes/ROCKCYCL.HTM>

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[www.nanooze.org](http://www.nanooze.org)

More Nanotechnology Resources  
[www.nnin.org/education-training](http://www.nnin.org/education-training)



## Allotropes of Carbon

**Graphite** – atomic planes slide easily over each other making it a natural lubricant.

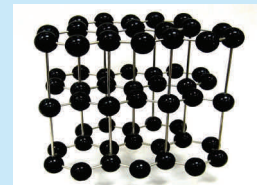


Image courtesy of R.Weller/Cochise College

**Diamond** – hardest naturally occurring substance



Image courtesy of R.Weller/Cochise College

**Buckminsterfullerene C<sub>60</sub>** – nicknamed “bucky ball”

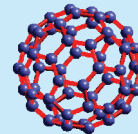


Image at US DOE: <http://www.osti.gov/accomplishments/smalley.html>

**Carbon nanotubes** – 100 times stronger than steel

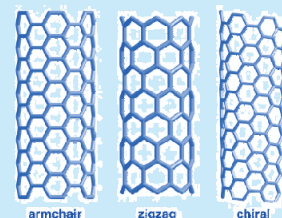


Image courtesy of Brian Grady, University of Oklahoma