

# Big Idea: Structure of Matter<sup>(1)</sup>

(1)- The Big Ideas of Nanoscale Science & Engineering: A Guidebook for Secondary Teachers. S.Y. Stevens, L.M. Sutherland, & J.S. Krajcik, NSTA Press, 2009.

Materials consist of building blocks that often form a hierarchy of structures. Atoms interact with each other to form molecules. These can combine to form nanoscale assemblies and structures.<sup>(1)</sup>

## Learning Goals<sup>(1)</sup>

1. Atoms are the fundamental building blocks of matter. The structure of atoms affects how they interact to form organized assemblies and structures, (e.g., molecules, extended solids, nanoparticles).
2. Properties inherent to the building blocks affect how they can interact with other building blocks, which affects the properties of a material.
3. Many materials consist of hierarchical structures. [1]

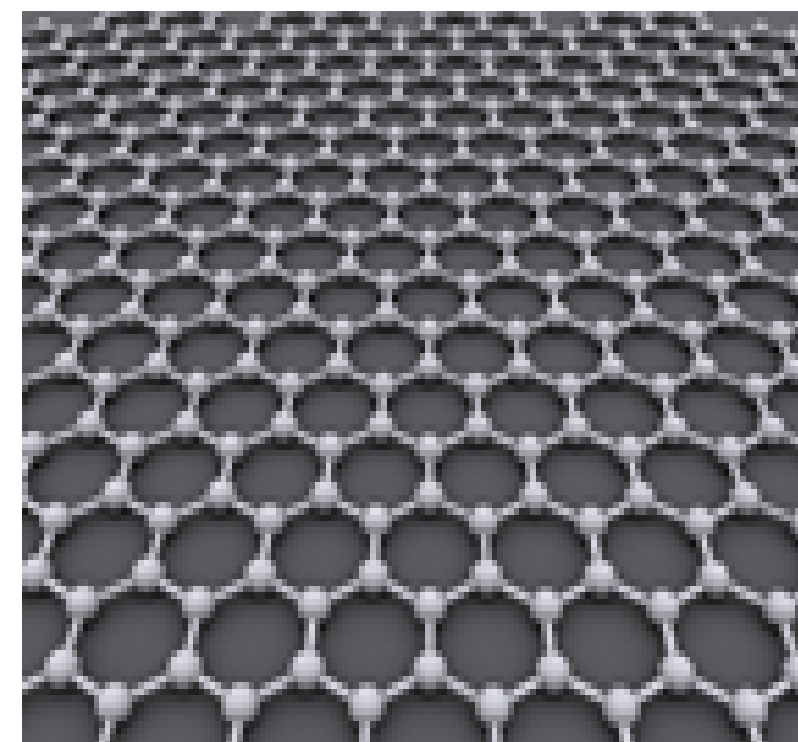


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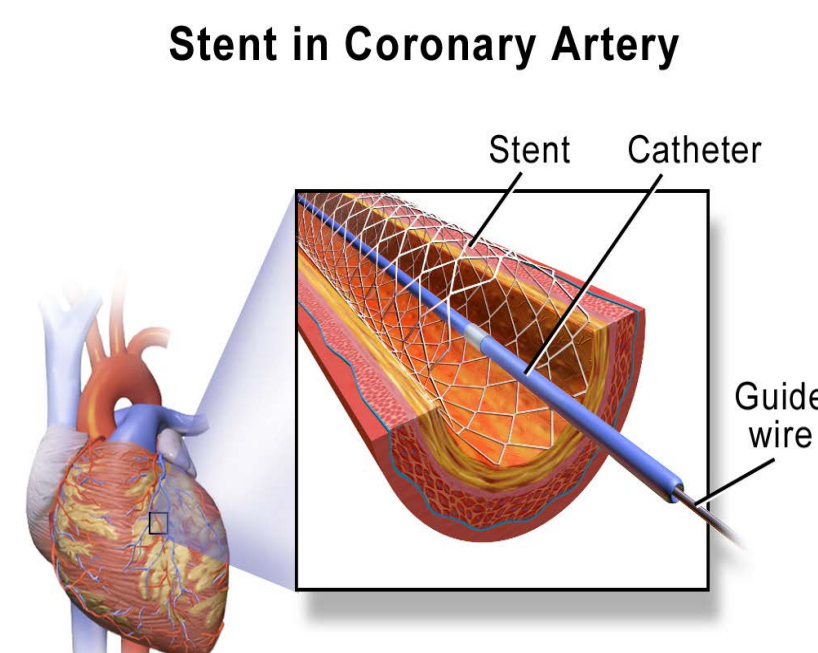
## Examples

To understand what a material's function and properties are, you need to understand its fundamental building structure, i.e., the type and arrangement of atoms. Allotropes of carbon provide excellent examples of how arrangement affects properties. In graphite, carbon atoms bond with 3 other C atoms in layers forming a "soft" material which is conductive. In diamond the C atoms bond with 4 C atoms creating a three dimensional structure which is the hardest substance and an insulator.

Pictured: Graphene an Allotrope of Carbon.

## Cutting-Edge Applications

Carbon nanotubes (CNTs), are being explored for use in miniaturized biosensors to tissue regeneration. Novel techniques are being developed to address the interaction of CNTs with living cells and tissues. Advances in surface chemistry has improved CNT bio-compatibility allowing their application as tissue scaffolding materials. One such application is the use of CNTs to improve the strength of catheters used in cardiovascular surgeries.



[wikimedia.org/wiki/File:Blausen\\_0034\\_Angioplasty\\_Stent\\_01.png](https://wikimedia.org/wiki/File:Blausen_0034_Angioplasty_Stent_01.png)  
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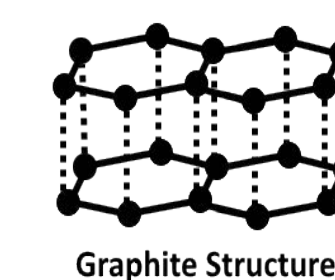
## Questions to Ponder

What are the different models that describe electron behavior? Can you explain them?

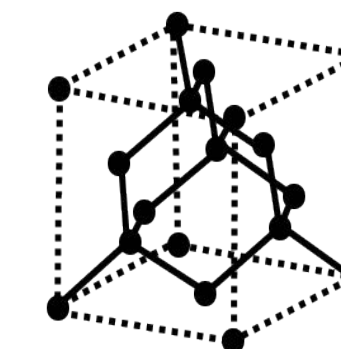
How does thermal motion affect the properties of a material?

What are the advantages and disadvantages of using nanoscale building blocks?

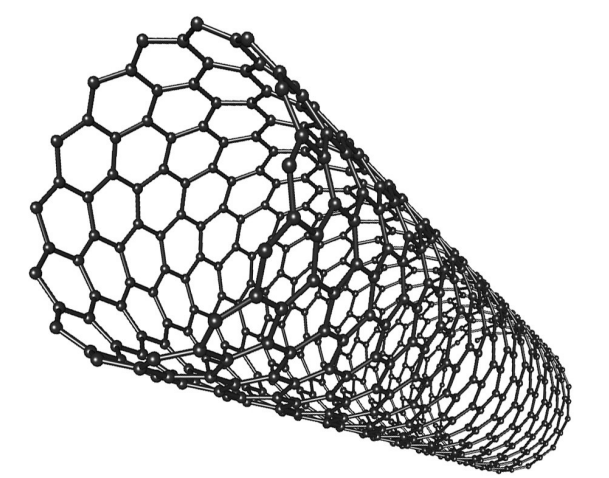
## Allotropes of Carbon



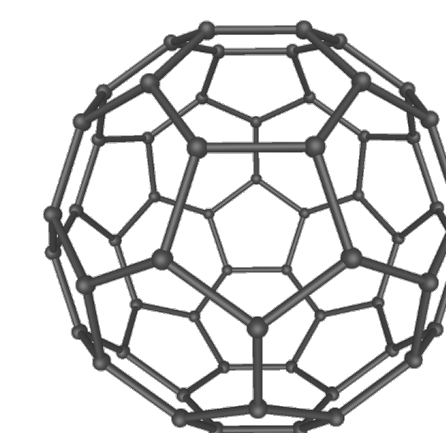
Graphite Structure



Diamond Structure



Carbon nanotube



Buckminsterfullerene C60

All images from Wikipedia