علم النانو في الفيزياء الطبية

Nanoscience in Medical Physics

LECTURE TEN

Asst. Prof. Dr. Forat Hamzah

CHAPTER TEN

Nanoscale Effect

The material properties change as their size approaches the atomic scale. This is due to the surface area to volume ratio increasing, resulting in the material's surface atoms dominating the material performance. Owing to their very small size, nanoparticles have a very large surface area to volume ratio when compared to bulk material, such as powders, plate and sheet. This feature enables nanoparticles to possess unexpected optical, physical and chemical properties, as they are small enough to confine their electrons and produce quantum effects. For example, copper is considered a soft material, with bulk copper bending when its atoms cluster at the 50nm scale. Consequently, copper nanoparticles smaller then 50nm are considered a very hard material, with drastically different malleability and ductility performance when compared to bulk copper. The change in size can also affect the melting characteristics; gold nanoparticles melt at much lower temperatures (300 °C for 2.5 nm size) than bulk gold (1064 °C). Moreover, absorption of solar radiation is much higher in materials composed of nanoparticles than in thin films of continuous sheets of material. While bulk materials have constant physical properties regardless of size, the size of a nanoparticle dictates its physical and chemical properties. Thus, the properties of a material change as its size approaches nanoscale proportions and as the percentage of atoms at the surface of a material becomes significant. Properties of materials are size-dependent in this scale range. Thus, when particle size is made to be nanoscale, properties such as melting point, fluorescence, electrical conductivity, magnetic permeability, and chemical reactivity change as a function of the size of the particle.