Chapter 71
Nanorevolution and Professionalizing University Education: Opportunities and Obstacles

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ABSTRACT

Nanotechnology (NT) is considered to constitute the basis of next technological revolution. It is a multidisciplinary and interdisciplinary subject covering physics, chemistry, biology, and engineering. The present chapter discusses various applications of nanotechnology with respect to the relation with industries and to develop the human resources in nanotechnology. Nanotechnology is progressing fast in the fields of electronics, textiles, packaging, auto and aerospace industries, sports, optoelectronics, environmental monitoring, food science, forensics, security, cosmetics, agriculture, medicines, etc. NT is impacting our daily life with fast pace, and thus can be considered as a driving force for industrial development. The science has long been working at this scale and below. Bionanotechnology or nanobiotechnology is an area in nanoscience, which is fast picking up for its application in human health and agriculture.

INTRODUCTION

Nanotechnology can be defined as the technology at the one-billionth of a metre, which is nothing but the design, characterization, synthesis and application of materials, structures, devices and systems at nanometer shape and size (Stylios et al. 2005; Ochekpe et al. 2009).

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Thus, the definition of nanotechnology is based on the prefix "nano" which means "dwarf" and more technically, "nano" means 10^{-9}, or one billionth. Hence, the word nanotechnology is used to refer to materials of size ranging from 0.1 to 100 nm; however, it is also inbuilt that these materials may have different properties, such as, physical strength, chemical reactivity, electrical conductance, magnetism, and optical effects from bulk materials due to their size

(Institute of Nanotechnology, May 2006, www.nanoforum.org.). Hence, nanotechnology is the branch of technology dealing with working at the atomic, molecular and supramolecular levels to create materials, structures, devices and systems with new nano scale manipulation of individual atoms, molecules and molecular clusters into different materials and devices having new and totally different properties (Roco, 2003; Ochekpe et al. 2009).

Scientifically, Nanotechnology includes application of materials, devices and systems with structures and components exhibiting new and significantly improved physical, chemical and biological properties (Miyazaki & Islam, 2007). Materials exhibit unique properties at nanoscale of 1 to 100 nanometre (nm). The changes in properties are due to increase in surface area to volume ratio (Williams, 2008). There are several examples for illustrating this. Macro scale opaque copper becomes transparent at nanoscale (Gao et al. 2003; Zong et al. 2005), inert platinum becomes a catalyst at nanoscale (Luo et al. 2005; Tian et al. 2007), and silicon, which is good insulator, becomes a conductor at nanoscale (Heron et al. 2007; Patel,, 2008).

The chapter is focused on revolution generated by Nanotechnology due to its applications in different fields like electronics, agriculture and medicines. In addition to this opportunities and obstacles have also been discussed.

BACKGROUND

The field of nanotechnology was laid by Richard Feynman of California Institute of Technology, who in 1959 stated that "There is plenty of room at the bottom" (Zong et al. 2005; Miyazaki & Islam 2007; Majumder et al. 2007). Feynman is known for manipulating materials at the scale of individual atoms and molecules (Sahoo et al. 2007). He also presented a technological vision of miniaturization of materials, manipulating and controlling things on a small scale called "Nanotechnology."

Despite the propaganda of nanotechnology in recent years, it is not a new technology, as Romans about 1600 years ago copied the color effect of butterfly wings, and in the British Museum, due to nanoparticles of gold and silver, glass cup looks jade green in natural light and an impressive red color when a bright light shines through it (Smith, 2006). Carbon nanoparticles are used for the manufacture of car tyres, while due to presence of nanoparticles in the atmosphere, the red and yellow colors are seen at sunsets (Smith, 2006).

Nanotechnology was also used by Indian craftsmen and artisans to make weapons and long lasting cave paintings about 2000 years ago. Studies confirmed the existence of carbon nanoparticles on sword of Tipu Sultan who was ancient ruler of the Kingdom of Mysore, India, and at Ajanta cave paintings in India. Richard Zsigmondy in 1902, for the first time observed and measured the nanoparticles, by using an ultramicroscope. In 1974, Norio Taniguchi used the term nanotechnology to refer to the engineering materials at nanoscale (Miyazaki & Islam 2007; Sahoo et al. 2007). Gerd Binnig invented scanning tunneling microscopy (STM) and Henrich Rohrer invented atomic force microscopy.

Saumio Iijima discovered carbon nanotubes in 1985, and the United States government launched the (NNI) National Nanotechnology Initiative-a federal visionary research and development programme for nanotechnology based investments through the coordination of 16 various US departments and independent agencies in 2000. These developments provide the way for the progress in research and further development in nanotechnology (Roco, 2004; Matija, 2004; Miyazaki & Islam 2007).