

## Chapter 3

# Carbon Nanotubes: Basics, Biocompatibility, and Bio–Applications Including Their Use as a Scaffold in Cell Culture Systems

**Towseef Amin Rafeeqi**

*Central Research Institute in Unani Medicine, India*

### **ABSTRACT**

*Carbon-based nanotechnology has been rapidly developing, with a particular interest in the bio-application of carbon nanotubes (CNTs) as a scaffold in tissue engineering. It is essential that the materials used in scaffold fabrication are compatible with cells, as well as with the biological milieu. Many synthetic polymers have been used for tissue engineering so far; however, many lack the necessary mechanical strength and may not be easily functionalized, in contrast to CNTs, which have shown very attractive features as a scaffold for cell culture system. In spite of many attractive features, the toxicity of CNTs is a prime concern. The potential applications of CNTs seem countless, although few have reached a marketable status so far and there is need of more studies on CNTs biocompatibility issues. This chapter aims to revisit the basics of CNTs with their bio-applications including their use as a scaffold in cell culture systems.*

DOI: 10.4018/978-1-4666-6304-6.ch003

Copyright ©2015, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

## **INTRODUCTION**

Nanotechnology is a creation and utilization of materials measured in billionths of a meter. Nanotechnology is poised to make potentially revolutionary innovations in areas of biomedical science such as, diagnostics, drug therapy, imaging and tissue engineering. Following the discovery of carbon nanotubes by Iijima (1991), carbon-based nanotechnology has been rapidly developing as a platform technology for variety of uses including biomedical applications. A particular area that is generating particular interest as illustrated by an increasing publication rate is the bio-application of carbon nanotubes as a scaffold in tissue engineering (Edwards *et al.*, 2009). The core of the tissue-engineered replacement is the biomaterial construct or scaffold, in which a given cell population is seeded. Ideally, a biomaterial scaffold should have well-controlled microarchitectures with well controlled pore sizes and porosity, reproducibility, biocompatibility, thermal and biochemical stability.

In tissue engineering, carbon nanotubes have been mainly used for structural support. There are various reports which suggest use of carbon nanotubes as a scaffold for cell culture (Harrison and Atala, 2007; Edwards *et al.*, 2009, Rafeeqi and Kaul, 2010a). While popular synthetic polymers such as poly(lactic-co-glycolic acid) (PLGA) and poly(lactic-acid) (PLA) have been used for tissue engineering, they lack the necessary mechanical strength. In addition, such polymers cannot easily be functionalized in contrast to carbon nanotubes which can be readily functionalized. In spite of many attractive features, the toxicity of CNTs is a prime concern, with several groups pointing to their similarity to asbestos fibers. CNT toxicity in both *in vivo* and *in vitro* studies has been attributed to various factors and there is need of more studies on CNT toxicity and biocompatibility issues. We should appreciate the pros and cons of each system and should make every effort to refine them to further enhance their therapeutic potential.

As we continue exploring nanotechnology for biomedical applications, it is essential for us to ensure that the nanotechnologies developed are safe. The focus of this book chapter is on basics of carbon Nanotubes with their method of preparation and purification, which is fundamental prerequisite for applications of carbon Nanotubes in biological system. Further, this chapter also deals with biocompatibility and bio-applications of carbon Nanotubes with emphasis on its use as a scaffold in cell culture systems.

29 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: [www.igi-global.com/chapter/carbon-nanotubes/115722](http://www.igi-global.com/chapter/carbon-nanotubes/115722)

## Related Content

---

### The Effects of Vertical Stress on the Liquefaction Potential Originated from Buildings in The Urban Areas: A Case Study

Mehmet Ozcelik (2017). *International Journal of Geotechnical Earthquake Engineering* (pp. 38-57).

[www.irma-international.org/article/the-effects-of-vertical-stress-on-the-liquefaction-potential-originated-from-buildings-in-the-urban-areas/188586](http://www.irma-international.org/article/the-effects-of-vertical-stress-on-the-liquefaction-potential-originated-from-buildings-in-the-urban-areas/188586)

### Characteristics of Chitosan Nanoparticles for Water and Wastewater Treatment: Chitosan for Water Treatment

Cayla Cookand Veera Gnaneswar Gude (2017). *Advanced Nanomaterials for Water Engineering, Treatment, and Hydraulics* (pp. 223-261).

[www.irma-international.org/chapter/characteristics-of-chitosan-nanoparticles-for-water-and-wastewater-treatment/176520](http://www.irma-international.org/chapter/characteristics-of-chitosan-nanoparticles-for-water-and-wastewater-treatment/176520)

### Effects of Soil Parameters Uncertainties on the Behaviour of Anisotropic Porous Media to Shear Waves

Amina Sadouki, Zamila Harichaneand Ayfer Erken (2019). *International Journal of Geotechnical Earthquake Engineering* (pp. 32-49).

[www.irma-international.org/article/effects-of-soil-parameters-uncertainties-on-the-behaviour-of-anisotropic-porous-media-to-shear-waves/252836](http://www.irma-international.org/article/effects-of-soil-parameters-uncertainties-on-the-behaviour-of-anisotropic-porous-media-to-shear-waves/252836)

### Optimal Placement of Viscoelastic Dampers Represented by the Classical and Fractional Rheological Models

Roman Lewandowskiand Zdzislaw Pawlak (2013). *Design Optimization of Active and Passive Structural Control Systems* (pp. 50-84).

[www.irma-international.org/chapter/optimal-placement-viscoelastic-dampers-represented/68907](http://www.irma-international.org/chapter/optimal-placement-viscoelastic-dampers-represented/68907)

### Used Product Pre-Sorting System Optimization Using Teaching-Learning-Based Optimization

(2014). *Computational Intelligence in Remanufacturing* (pp. 95-112).

[www.irma-international.org/chapter/used-product-pre-sorting-system-optimization-using-teaching-learning-based-optimization/90203](http://www.irma-international.org/chapter/used-product-pre-sorting-system-optimization-using-teaching-learning-based-optimization/90203)