

Chapter 42

Interdisciplinary Course Development in Nanostructured Materials Science and Engineering

Kenneth L. Roberts
King Faisal University, Saudi Arabia

ABSTRACT

Modern industrial processes are presently adapting to the use of multiscale production techniques where consumer products can be made at the mesoscale and also approaching atomic, or the nanoscale level. Coupled with the fact that classical Science, Technology, Engineering and Mathematics (STEM) education typically does not address nanoscale science and engineering topics in most technical courses, this condition could potentially leave countless STEM students around the world relatively unprepared for the 21st century marketplace. This chapter focused on the development of the nanostructured materials science and engineering discipline from the most recent research and development topics to the integration of this information internationally into the technical classroom. The chapter presented future work on the adaptation of the previous research and educational work on this topic at the College of Engineering at King Faisal University in Saudi Arabia and suggestions were offered for successful new nanoscale science and engineering course development.

INTRODUCTION

Over the past twenty years, nanomaterials science and engineering has become almost pervasive in the technical disciplines. In the early 1990's, the reporting of material properties on the scale of submicron scale using scanning and/or transmission electron microscopy seemed to be at the cutting edge. After the discovery of the Buckyball (C₆₀ or Buckminsterfullerene), new terms such as nanotubes, nanoparticles, nanowires and a varied assortment of atomic scale crystalline morphologies quickly gained notoriety. Unfortunately, not every academic program, especially B.S. and M.S. level granting programs, had

DOI: 10.4018/978-1-5225-1798-6.ch042

access to nanoscale characterization equipment such as transmission electron and scanning tunneling microscopes, required to fully peer into the nanoscale. Thus a nanoscale divide in Science, Technology, Engineering and Mathematics (STEM) education had also begun. Unfortunately many STEM students from universities with developing research infrastructures gained college and graduate level degrees without significant training in nanoscale science and engineering.

BACKGROUND

Development and Implementation of Nanoscale Materials Research and Education Initiatives: Global Initiatives

Since the beginning of the 21st century, several countries including the United States have begun large government-funded initiatives to prepare pre-college, college-level and graduate-level students for careers in nanoscience, nanotechnology and nanoengineering. In the U.S., the National Nanotechnology Initiative (NNI) first approved for funding in 2001 sought among other goals to increase the interdisciplinary nature of research and development and to explore the broad societal impacts of nanotechnology (Roco, Mirkin, & Hersham, 2011). International literature have reported from the late 1990's on the development and implementation of nanoscale materials research, and educational initiatives are still ongoing. In Table 1, a comparison of national government support of nanotechnology research and development funding is provided.

In many countries such as Germany, South Korea and the Russian Federation, the primary goal of nanoscale research centers and institutes was initially to provide professional conduits for corporate researchers and academics to develop nanoscience research into finished industrial products (Rieke & Bachman, 2004; So, Kim, Chung, & Jhon, 2012; Klochikhin, 2011). Universities were tasked to focus on nanoscale student training mainly for industrial applications research for commercial products and technical publications. Over time, the participating universities developed graduate and undergraduate nanoscale education programs. For example during the 2004-2005 academic year in the E.U., there were 19 Ph.D., 78 M.S., and 28 undergraduate nanotechnology programs (Malsch, 2008).

On the state of global nanoscale educational initiatives at the university level, there have been recent reviews published (Feather & Aznar, 2011; Mohammed, Lau, Zaharim, & Omar, 2012). The work by

Table 1. Federal/national government nanotechnology research & development funding, 2008

Country/Region	Government Nanotechnology R&D Funding (Millions \$ U.S.)	Specific Nanotechnology R&D (\$ U.S./Capita)
European Union	~1770	~4.6
U.S.	~1550	~5.1
Japan	~950	~7.3
China	~430	~0.4
Korea	~310	~6.0
Taiwan	~110	~4.5

(Roco et al., 2011).

17 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/interdisciplinary-course-development-in-nanostructured-materials-science-and-engineering/175730

Related Content

Compact Dual Fractal Curves-Based Microstrip Patch Antenna for 5G Applications

Manpreet Kaur (2023). *Innovative Smart Materials Used in Wireless Communication Technology* (pp. 125-140).

www.irma-international.org/chapter/compact-dual-fractal-curves-based-microstrip-patch-antenna-for-5g-applications/319923

Tribologic Analysis, Wear Evolution and Torque Trend Estimation of an LSD Clutch Pack

Amedeo Tesi, Emanuele Galvanetto, Claudio Annicchiarico and Renzo Capitani (2017). *International Journal of Surface Engineering and Interdisciplinary Materials Science* (pp. 16-36).

www.irma-international.org/article/tribologic-analysis-wear-evolution-and-torque-trend-estimation-of-an-lsd-clutch-pack/173731

Artificial Intelligence in Orthopedic Implant Model Classification

S. Sushma, T. Anuradha, D. R. Denslin Brabin and A. Jose Anand (2023). *Handbook of Research on Advanced Functional Materials for Orthopedic Applications* (pp. 93-106).

www.irma-international.org/chapter/artificial-intelligence-in-orthopedic-implant-model-classification/329747

Introduction of Environmental Materials

Takaomi Kobayashi (2017). *Applied Environmental Materials Science for Sustainability* (pp. 1-18).

www.irma-international.org/chapter/introduction-of-environmental-materials/173851

Optimization of Fractal Dimension of Turned AISI 1040 Steel Surface Considering Different Cutting Conditions: Fractal Dimension of Turned Steel Surface

Arkadeb Mukhopadhyay, Manik Barman and Prasanta Sahoo (2019). *International Journal of Surface Engineering and Interdisciplinary Materials Science* (pp. 19-33).

www.irma-international.org/article/optimization-of-fractal-dimension-of-turned-aisi-1040-steel-surface-considering-different-cutting-conditions/234397