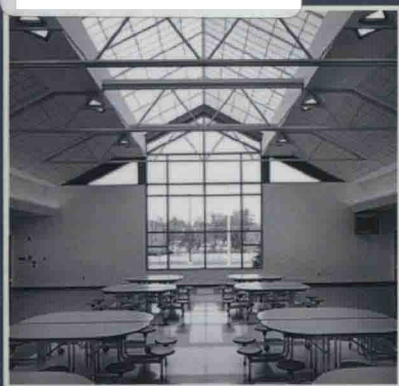


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# Nanotechnology in eco-efficient construction

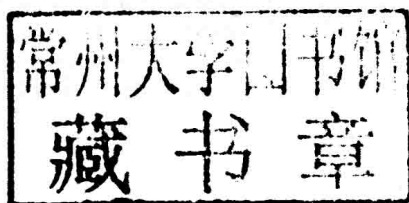
Edited by F. Pacheco-Torgal, M. V. Diamanti,  
A. Nazari and C-G. Granqvist

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# Nanotechnology in eco-efficient construction

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Edited by  
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and C-G. Granqvist



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# Introduction to nanotechnology in eco-efficient construction

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**Abstract:** This chapter provides a brief overview of some important aspects of nanotechnology starting with its earlier steps and how countries are trying to establish an advantageous position in this field. China deserves a special mention because it is already the second largest producer of nanotechnology papers after the United States. The need for nanotechnology in the construction sector is emphasized. An outline of the book is given.

**Key words:** nanotechnology, eco-efficient construction, UN Millennium Goal, concrete, energy efficiency.

## 1.1 Introduction

Nanotechnology is a hot topic in current research, defined by Drexler (1981) as the manufacture of products using dimensions and precision of between 0.1 and 100 nm ( $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$ ). It should be noted, however, that two decades prior to Drexler's work, the physicist Richard Feynman made a speech entitled 'There's plenty of room at the bottom' at a 1959 meeting of the American Physical Society at Caltech; this is considered to be the beginning of the era of nanotechnology era (Feynman, 1960).

In 1981 an expert group appointed by the European Commission was not able to agree on a firm definition of nanotechnology, but did arrive at a working definition for nanoscience and nanotechnology (NST) as 'the manipulation, precision placement, measurement, modeling or manufacture of sub-100 nanometer scale matter' (Glänzel *et al.*, 2003). The rapid evolution of research in this area is demonstrated by the growth rate of papers published with the 'nano-' prefix in the title in the period between 1992 and 2001, which increased exponentially with a doubling time of 2 years (Glänzel *et al.*, 2003). Economic estimates regarding advances in nanotechnology are still more striking: it is predicted that products and services related to nanotechnology could reach several hundred billion euros by the end of the decade (NSF, 2001; Compañó and Hullmann, 2002).

Dozens of countries already have national strategies in place and have begun to implement national nanotechnology plans (Rieke and Bachmann, 2004; Soltani *et al.*, 2011). According to Arnall and Parr (2005), countries



are trying to establish an advantageous position ‘so that when nanotech applications begin to have a significant impact in the world economy, countries are able to exploit these new opportunities to the full’. Europe has assigned 4.865 billion euros to ‘Nanosciences, Nanotechnologies, Materials and New Production Technologies’ as part of the 7th Framework Programme for the 2007–2013 period. In the United States, a dedicated nanotechnology act was signed into law, which set aside 3.679 billion dollars of funding for the 2005–2008 period (Salerno *et al.*, 2008). China has identified nanotechnology as a priority area in its national agenda of science and technology development, and has increased R&D investment in the field. China has consequently emerged as one of the key global players in nanotechnology, producing the second largest number of nanotechnology papers after the United States (Wang and Guan, 2010, 2012).

Of course, nanotechnology is not entirely risk-free, with issues already raised with regard to the potential toxicity of nanoparticles and a new problem of the disposal of nanowastes (Bystrzejewska-Piotrowska *et al.*, 2009; Tyshenko, 2010). Despite these risks, however, Arnall and Parr (2005) quote Mihail Roco, the senior advisor for nanotechnology to the NSF, who stated that ‘early payoffs will come in electronics and IT, and medicine and health’. Malanowski and Zweck (2007) also report that although almost all fields of industry are expected to be affected by nanotechnology by 2015, the areas most affected will be ‘chemistry, life sciences and electronics’.

## 1.2 The need for nanotechnology in the construction sector

Very few nanotech applications are currently used in the construction sector, which in fact seems to have been somewhat neglected by nanotech research to date. A search for the terms ‘nanotechnology’ and ‘eco-efficient construction’ in journals listed in Scopus revealed only five papers, all related to cement and concrete. Of course, many more papers examining the role of nanotechnology in cement and concrete have been published; however, the number is very low compared to other major areas of current research. Moreover, much more work on standardization is required to ensure that high quality investigations into the use nanotechnology in cement and concrete applications can reach the global market (Sanjuan *et al.*, 2011).

It is understandable that nanotech research in today’s economically driven society has so far been focused mainly on high profit areas such as those mentioned above. It is rather strange, however, that the same society so easily forgets the economics of environmental problems such as the probable meltdown of the world economy associated with global warming (Stern, 2006). Nanotechnology priorities should therefore be driven by