

Book review:

Is nanotechnology an efficient tool in eco-construction?

Lech CZARNECKI

The Instytut Techniki Budowlanej (ITB), Warsaw 00-611, Poland

E-mail: l.czarnecki@itb.pl

<https://doi.org/10.1631/jzus.A19BR001>

F. PACHECO-TORGAL, M.V. DIAMANTI, A. NAZARI, C.G. GRANQVIST, A. PRUNA, S. AMIRKHANIAN (Eds.), 2018. *Nanotechnology in Eco-efficient Construction: Materials, Processes and Applications*, 2nd Edition. Woodhead Publishing, UK.

eBook ISBN: 978-0-08-102642-7

Paperback ISBN: 978-0-08-102641-0

This intriguing question has been asked constantly (Teizer, 2012; Czarnecki, 2013). Because the global construction industry produces tens of millions of products annually, even a small nano-impulse may be the cause of a huge change. The question is very important, but the answer could also be very significant because of the contra positions of “eco-efficient construction” as a civilisation challenge and “nanotechnology” as the contemporary mainstream in the development of technology.

A positive answer to the title question is presented in a very professional and potent way in the book “Nanotechnology in Eco-efficient Construction: Materials, Processes and Applications”. The book provides answers in a holistic approach covering all three levels: materials, processes and—what makes the object of study more convincing—applications. “Application” parts are particularly of value because most readers gain knowledge of nanotechnology or the topic in general only by description, not by acquaintance. This means that the approach to description matters.

Knowledge in the book is well-structured, up-to-date, and very well-referenced, as in other books edited under the leadership of Fernando PACHECO-TORGAL (Braga, Portugal). Prof. PACHECO-TORGAL is an internationally renowned

editor, reviewer, and author in the field of civil engineering and the broadly understood philosophy of technical sciences. Other notable editors should also be acknowledged for their tremendous work: Maria V. DIAMANTI (Milano, Italy), Ali NAZARI (Melbourne, Australia), Claes G. GRANQVIST (Uppsala, Sweden), Alina PRUNA (Bucharest, Romania), and Serji AMIRKHANIAN (Alabama, USA).

Like the global subject of the book, the authorship of the chapters is also global and diverse. There are 72 authors from 5 continents and 20 countries. However, from the reader’s point of view, despite this diversity, the book gives the impression of integral continuity. Moreover, the whole is not only scholarly, but also interesting. The magnitude of essence claimed in the book, the size of the book, and the order of content make the book literally and figuratively great.

The book has a huge number of references (2957) including some from 2018! Each chapter has its own substantial reference list (a minimum of 17 and a maximum of 233 items). It is not only a real advantage of this book, but it is a strong thrust for further development, particularly for young researchers. This domain is growing rapidly and continuously. In the Editor’s notes, the sentence “knowledge and best practices in this field are constantly changing” can be found. This, the second edition of the book, which appears only five years after the first publication, proves that it is a “hot topic”. It is undoubtedly also a very “lively topic”.

A few words about the first edition: 443 pages were divided into 3 parts and 16 chapters. The new edition has 876 pages, 5 parts, and 31 chapters. In five years, the book’s volume has almost doubled. What is new? Added value can be considered on two levels:

1. Modernization of the existing text. A spectacular example is the title of Chapter 2: Influence of nanoparticles on the strength of ultra-high performance concrete. “Ultra-high” signifies a compressive strength above 150 MPa. In 2013, the same chapter was named “The influence of nanoparticles on the

strength of high performance concrete”. “High” signifies a compressive strength above 50 MPa. It is a measurable yardstick of comparison.

2. The 15 new chapters, along with the existing ones, were divided into five new parts: Part 1: Mortars and concrete related applications; Part 2: Applications for pavements and other infrastructure materials; Part 3: Applications for building energy efficiency; Part 4: Photocatalytic applications; Part 5: Toxicity, safe handling, and environmental impacts.

In this second edition, the book is organized around two main topics: Nanoelements (nanoparticles, nanofibers) in construction made materials; Protective nano-coatings on construction materials.

The first topic refers mainly to concrete and asphalt mixtures and describes how particular nano-elements modify the performance of construction composites. The second topic covers various thin coatings conferring enhanced performance by nanomodification and deposition on construction materials, and includes ice protection concrete, steel corrosion protection, fire retardants for wood protection, heat insulation (particularly aerogel-enhanced), energy saving, self-cleaning, and even photocatalytic mitigation of the harmful effects of air pollution and inhibition of fouling by microalgae. Separate chapters include: nanocomposites for structural health monitoring, glazing technologies, electrochemical foil for glass lamination, and photocatalytic water purification. Great emphasis (almost half of the book) is placed on construction health monitoring in real time and the self-healing ability of existing structures. Fifteen percent of the chapters deal with building energy efficiency (cooling, heating, and insulation) as a way to minimize the impact of climate change. Interesting, but a little removed from the title keywords of materials, processes, and applications, is a chapter on nanoindentation for evaluation of the properties of cement hydration products.

The significance of the fifth part, which includes toxicity, safe handling, and environmental impacts, cannot be overestimated. This is the last part, but it is the gateway for the future. This is the most important factor determining full-scale implementation. From the analysis presented, many questions and an evident threat arise. Further research and studies are needed.

The book contains a comprehensive study of nanotechnology applications in construction at various levels of detail according to the state of the art. The question arises: what (if anything) is missing?

In the book, only nanocoatings for protection against steel corrosion are discussed. Nanomodifiers in steel have been completely omitted contrary to the very old tradition in this field, e.g. Damascus steel. Perhaps the economic aspect has also not been sufficiently accented.

Apart of those issues, it is a positioning book—it is the leader in this field, expresses development trends and expectations, and even promises. These issues are important not only as future plans, but also here and now. The title “Nanotechnology in Eco-efficient Construction” refers to at least three of the six key enabling technologies (KETs): nanotechnology, advanced materials, and advanced manufacturing technologies (Pacheco-Torgal, 2014; https://ec.europa.eu/growth/industry/policy/key-enabling-technologies_en). This is a good example of combining European priorities to provide the basis for innovation in a range of products across all industrial sectors. However, their importance makes them key elements not only in Europe, but also globally (Czarnecki and van Gemert, 2017). This topicality is one of the extra values of the book.

In the introduction to the book, Prof. Pacheco-Torgal notes that: “nanotechnology research has given very little importance to the factors that are important for the construction industry and that show a gap between what researchers consider important and what the construction industry needs.” When the second edition of the book hits the shelves, the sentence will no longer sound as strong—there will be a change to a much more optimistic opinion.

References

- Czarnecki L, 2013. Sustainable concrete; is nanotechnology the future of concrete polymer composites? *Advanced Materials Research*, 687:3-11.
<https://doi.org/10.4028/www.scientific.net/amr.687.3>
- Czarnecki L, van Gemert D, 2017. Innovation in construction materials engineering versus sustainable development. *Bulletin of the Polish Academy of Sciences: Technical Sciences*, 65(6):765-771.
<https://doi.org/10.1515/bpasts-2017-0083>
- Pacheco-Torgal F, 2014. Eco-efficient construction and building materials research under the EU Framework Programme Horizon 2020. *Construction and Building Materials*, 51:151-162.
<https://doi.org/10.1016/j.conbuildmat.2013.10.058>
- Teizer J, 2012. Nanotechnology and its impact on construction: bridging the gap between researchers and industry professionals. *Journal of Construction Engineering and Management*, 138(5):594-604.
[https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000467](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000467)