BOOK REVIEW

Green Nanotechnology: Solutions for Sustainability and Energy in the Built Environment

G. B. Smith and C. G. Granqvist , xiii+447 pages, ISBN 978-1-4200-8532-7, CRC Press, Boca Raton, Florida, USA (2011), US $79.95 hardcover.

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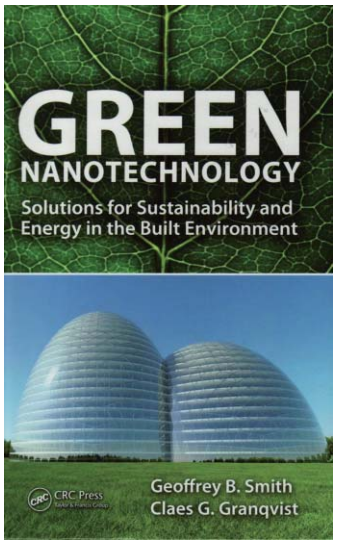

Earlier this week, on February 3, 2011, President Barack H. Obama stopped by at Penn State to present his Energy Innovation Hub plan encompassing three university–industry–government partnerships. One of the three aims is to significantly improve the energy efficiency of buildings—from single-family dwellings to skyscrapers—in the United States. "Now, that may not sound too sexy: energy-efficient buildings," Obama said to some laughter, but, as the built environment is responsible for 40% of the energy consumption in the country, he estimated that US businesses could save nearly US $40 billion a year by reducing their energy consumption. In the bargain, the adverse effects of energy generation and distribution on the natural environment would also be lessened.

Well, I disagree with the President. The topic of energy-efficient buildings is actually very "sexy" because it involves nanotechnologies. As Geoffrey B. Smith, who serves on the editorial board of this journal, has recently commented:[1] "Solutions to the urgent challenges of environment degradation, resource depletion, growth in population, and cities, and in energy use, will rely heavily on nanoscience. . . . Nature has shown us how the complexity inherent in nanostructures enables harmony with the environment."

Locating and designing buildings to exploit dominant wind patterns and insolation flux directions definitely reduces operational costs, a claim made by Penn State for a new building for the School of Law on its main campus. Further economy comes from using materials for windows, skylights, roofs, and facades for both light inflow and weather-dependent inflow or outflow of thermal energy. Appropriate selection of materials for environmentally harmonious design automatically reduces energy consumption, and the basic principles involved are explained in Chap. 2 of the book under review.

Both Smith and Granqvist, the two authors of the book, are eminent optical scientists with a longstanding fondness for the visible and the infrared properties of particulate composite materials. Naturally, they underscore the centrality of nanophotonics[1] for energy-efficient buildings by laying out in Chap. 3 the optical properties of chromogenic, plasmonic, spectrally selective, and other classes of materials; thin films; and nanocomposite materials. The emphasis is not on

mathematical descriptions of constitutive tensors and homogenization formalisms; rather, the authors present their distillation of research results that are relevant to the management of light and thermal energy.

The authors visit window materials and indoor lighting, particularly daylighting, in great detail in Chaps. 4 and 5. A variety of spectrally selective materials that can be electrically controlled and respond to ambient light and temperature are discussed in about 70 pages. Another 50 pages are devoted to skylights, light pipes, light diffusers, luminescent solar concentrators, and LED lighting. In comparison, Chap. 6, with just about 35 pages on solar thermal collectors and photovoltaic technology, appears a bit short. However, the harvesting of solar energy has been a major research topic for at least four decades, and the authors have done well to provide several references, not the least of which are two wonderful books written by Green.[2,3]

For millennia, the exteriors of buildings in warm countries have been painted in shades of white to keep their interiors cool. This traditional practice is developed further for reducing summer air-conditioning costs in Chap. 7, with a summary on high-albedo paints—a class of composite materials. Can we reduce the global atmospheric temperature by expelling radiation in certain spectral regimes into outer space? This intriguing possibility is also dealt with in Chap. 7, comprehensively and with recommended action items.

Chapter 8 provides ancillary material—on sensing air quality inside buildings, using light to clean surfaces, and thermal insulation as well as energy storage, possibly using nanomaterials.

The book concludes in Chap. 9 with a vision of a "nanoworld." All technoscientists, not only physicists and materials researchers, would do well to read the list of 17 characteristics that the Smith–Granqvist vision possesses. These characteristics delineate a blueprint for research directions, only some of which can be guessed from my short review.

A remarkable feature of this book are the bridges built throughout the volume with contemporary research topics through call-out boxes. An example of such a topic is furnished by optical cloaks, while another is the morphology of thin metal films comprising both percolative networks and isolated nanoparticles. The book is profusely illustrated, mostly in black and white but also with 10 pages of multicolored illustrations. Occasional flashes of quiet humor grace the book; I will let you discover examples all by yourself.

Another remarkable feature of this book is its price. While research monographs cannot sell by the hundreds of thousands like bodice-busters at supermarket checkout counters and therefore must cost more, in recent years certain publishers from both Europe and the United States have made them unaffordable to young doctoral students as well as middle-aged full professors. Happily, CRC Press has offered this book at a price less than that of dinner for two at a medium-priced restaurant in New York. Other academic publishers should take note.

In the preface, the authors complain (p. xvii) "that media of various kinds—not excluding scientific journals—tend to emphasize costly and long-term solutions at the expense of the functional, affordable, and near-term options." Whether or not the media take note of their book, researchers must. Politicians of certain stripes may not have embraced the emergence of climate change, and many sections of the general public may be oblivious to the same, but technoscientists must embrace environmentalism as a fundamental ethic for humanity. Plus, President Obama is offering federal megadollars for both technoscientific research and entrepreneurial techno-ventures.

References

1. G. B. Smith, "Commentary: Environmental nanophotonics and energy," *J. Nanophoton.* **5**, 050301 (2011).
2. M. A. Green, *Solar Cells: Operating Principles, Technology, and System Applications*, 2nd ed., Bridge Printery, Sydney, Australia (2002).
3. M. A. Green, *Third Generation Photovoltaics: Advanced Solar Energy Conversion*, Springer, Berlin, Germany (2003).