

Understanding Advances in Nanotechnology: Minimizing Risks and Maximizing Benefits with Application of the Appropriate Governance Framework

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ABSTRACT

“Nanotechnology” is a word that has come a long way. Until recently most people associated nanotechnology with science fiction-based accounts that tended to focus on fantastical devices and applications. Due to developments in nanoscience (e.g., greater control over atomic structure and relatively better predictability of nanoscale properties), nanotechnology has entered the commercial realm, and it has begun simultaneously to stimulate the development of new governance frameworks. In this article, the author discusses potential benefits and risks and examines a select set of frameworks for governing this technology.

Keywords: Benefits, Governance, Nanomaterial, Nanotechnology, Risks

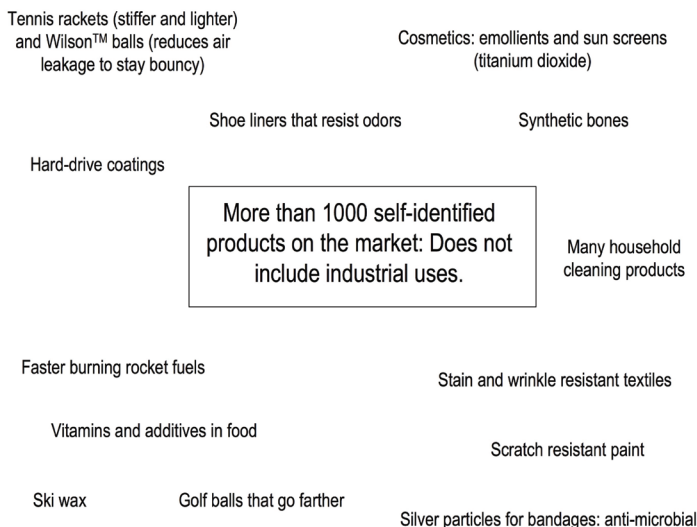
WHAT IS NANOTECHNOLOGY?

Nanoscience and nanotechnology are revolutionizing science and technology, while simultaneously challenging regulators and policymakers throughout the world (Mehta, 2002). These fields enable scientists to create organic and inorganic matter on an atom-by-atom or molecule-by-molecule basis, and a vast array of applications are transforming medicine, biotechnology, agriculture, manufacturing, materials science, aerospace, information technology, and telecommunications, to name just a few examples.

Since nanotechnology is a powerfully transformative technology, it is critical to understand many complex issues before the technology becomes too difficult to manage. Nanotechnologies are diverse and effects manifold, and it is likely that several decades will be required for these effects to be fully felt. Consequently, nanotechnology will coexist with established technologies rather than suddenly replace them, and the range and diversity of products on the marketplace, and in laboratories, that contain particles or structural features produced through applications of nanoscience is staggering, and somewhat alarming given the global absence of regulations specifically dedicated to these processes and products. A joint initiative between

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Figure 1. Examples of common applications involving nanotechnology



the Woodrow Wilson International Center For Scholars and the Pew Charitable Trusts, entitled “The Project On Emerging Nanotechnologies,” provides on their website (<http://www.nanotechproject.org/inventories/consumer/>) with a searchable inventory of more than 1000 consumer products where the manufacturer has disclosed voluntarily that nanoscale processes are used (Figure 1).

THE BENEFITS OF NANOTECHNOLOGY

Nanotechnology promises breakthroughs that will revolutionize disease detection and treatment, enhance environmental protection, produce and store energy, remediate contaminated soil, and lead to more targeted drug delivery (Table 1). There is even hope that advances in nanotechnology will be of direct value to the developing world (Salamanca-Buentello et al., 2005), and of course there are dissenting views as well (Mehta, 2008).

In the United States, the National Nanotechnology Initiative (NNI) was established in 2000 to examine ways to create the knowledge

base required to exploit fully technological innovations arising from nanoscience, and consequently the U.S. federal government allocated \$423 million for that purpose during the fiscal year 2001, and has steadily increased funding ever since. Several other countries have made similar kinds of investments, and in 2001 the National Research Council of Canada earmarked \$120 million to create the National Institute for Nanotechnology at the University of Alberta (NRC, 2001). According to Canada’s National Research Council (NRC), “The economic and social impact of nanotechnology may be profound: discoveries and applications of nanotechnology could lead to a new industrial revolution in the coming century, and to commercial markets as large as \$1.5 trillion per year within 10-15 years” (NRC, 2005).

The applications of nanotechnology, particularly in the biomedical realm, involve a postulated trillion-dollar impact with otherwise undreamed of benefits for health care, public safety, environmental monitoring, and forensics (Pilarski et al., 2004). For example, nanoscale manipulations may enable tissue regeneration, in vivo medical monitoring by nanoscale

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