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FEATURE BOX

China, Nanotechnology, and the Environment

By Louise Yeung and Evan Michelson

Nanotechnology, the emerging field of manipulating matter at the molecular or atomic level, has experienced tremendous growth in recent years. New nano-enhanced products, ranging from stain-resistant fabrics to anti-aging creams, are already available for purchase on store shelves and over the Internet. As this new technology advances, many experts are hopeful that the beneficial applications of nanotechnology will not only lead to new consumer products, but that they will also provide remedies to numerous environmental problems. Promising environmental applications range from the development of new energy storage and conversion systems to advanced water and air purification treatments. China—which is one of the world's largest investors in nanotechnology research and development, with the Chinese government spending nearly $250 million on nanotechnology in 2005—could greatly benefit from such nanotechnology applications in order to address the country's growing pollution and severe energy shortages.[1]

A Selection of Nanotechnology Consumer Products. © 2006 - David Hawxhurst/Wilson Center.

ENVIRONMENTAL APPLICATIONS FOR NANOTECHNOLOGY

Water Purification. With nearly half of its rivers running black at Grade V or worse, water pollution is one of China's major challenges. Many scientists around the world are seeking to develop effective nano-enhanced water treatment products. A variety of approaches are currently being explored, including the development of nanotechnology membranes for water detoxification[2] and the use of nanomagnets or charged nanomaterials to remove arsenic, oil, heavy metals, salt, and other pollutants from the water.[3] Unlike traditional filters, many of these newly created systems use charged nanomaterials to attract pollutants, which can then be easily extracted from the water. These nanomaterials can later be separated from the pollutants for reuse. Even more advanced purification methods, such as the use of zinc sulfide or titanium dioxide nanomaterials as catalysts to oxidize pollutants, may also be possible in the future. The advantage of this process is that it breaks down pollutants into less toxic substances.[4]

Air Purification. Sixteen of the twenty most polluted cities in the world are located in China and coal burning for energy has caused acid rain in nearly two-thirds of the country.[5] To help mitigate these air quality problems, ongoing research is hoping to develop nanomaterials with the capability of oxidizing airborne pollutants by photocatalysis, a process that converts contaminants into less toxic substances.[6]

Energy Efficiency. Energy shortages and air pollution from coal are central national security concerns in China. Nanotechnology's potential to improve efficiency in energy storage, production, and conversion are developments that may be crucial to China's future. Scientists are currently fine-tuning cost-effective nano-enhanced photovoltaic films to generate solar power that can be cheaply installed.[7] New nano-enabled materials promise to make rechargeable batteries more efficient and longer lasting.[8] Finally, by engineering materials, like metals or ceramics, to be more lightweight and durable, nanotechnology can increase the energy efficiency of buildings and their heating and cooling systems.

CHINESE NANOTECHNOLOGY INITIATIVES

China's investments in nanotechnology have begun to translate into world-class research results in terms of published papers, paper citations, and patents. For instance, a review by the Asia-Pacific Economic Cooperation (APEC) in 2001 indicated that China followed only the United States and Japan in terms of the number of nanotechnology papers published that year. In 2003, the number of nanotechnology related patent applications from China ranked third in the world, behind the United States and Japan.[9] Efforts by both government and industry have been behind China's rapid ascent to becoming a global nanotechnology leader, most notable is the National Center for Nanoscience and Technology and private company investments.

National Center for Nanoscience and Technology (NCNST). Established in March 2003 by the Chinese Academy of Sciences and the Ministry of Education, NCNST is a nonprofit organization housed within both Beijing and Tsinghua universities. NCNST conducts research in nanoprocessing, nanomedicine, and nanostructures. One of its main focus areas includes environmental application research that has, for example, led to the development of nanoporous zinc sulfide nanomaterials that can be used for photodegradation (disintegration of toxic substances in water using sunlight). These materials evenly disperse throughout water without clumping and they are slightly larger than other types of nanomaterials, which allows for both effective cleanup and easy collection and separation from toxins. In fact, similar materials are already in use as part of a self-cleaning glass coating on the newly built National Opera House in Beijing.

Private Companies. As is the case in many countries throughout the world, Chinese firms are beginning to make the transition from basic research to the commercialization of nanotechnology. In March 2006, the Project on Emerging Nanotechnologies at the Woodrow Wilson Center released an online inventory that now contains nearly 300 manufacturer-identified, nanotechnology-based consumer products that are available on the market from 15 countries, including China.[10] Products in the inventory cover a wide range of sectors—from cosmetics and personal care items to dietary supplements and cooking supplies, from automotive and home improvement products to stain-resistant clothing. Large and small enterprises are buying, selling, and marketing internationally many such nanotechnology-based products.

NGO FOCUS ON POTENTIAL ENVIRONMENTAL, HEALTH, AND SAFETY RISKS

While nanotechnology holds the promise to alleviate many environmental problems, some researchers and citizen groups are concerned about the potential risks nanotechnology poses to the environment and human health, because of the technology's ability to manipulate matter in a novel way. The effects of nanomaterials—when ingested, inhaled, or applied dermally—remain largely unknown, and there are currently no internationally coordinated risk research and oversight strategies designed to investigate and manage any potential environmental, health, and safety risks that may arise. While such risk research has been ongoing in the United States and the United Kingdom for a few years, China has only recently begun to invest in such research through the establishment of a Nanosafety Lab under the auspices of the NCNST in Beijing. Though much more work needs to be done in this area, any real or perceived hazards that may emerge in the near future may have the effect of hindering public trust in government and industry—both in more developed countries, such as the United States, and in more developing countries, such as China—to manage the effects posed by this emerging technology.

Moreover, while there is an increasing number of Western nongovernmental organizations (NGOs),

such as Friends of the Earth and the ETC Group, focused on mobilizing their constituencies around this issue, it appears that Chinese NGO attention on nanotechnology is lagging. A number of Western environmental organizations have called for a moratorium, or even an outright ban, on nanotechnology activities until more risk research can be conducted.[11] Additionally, many organizations have argued that misleading advertising, a lack of accurate labeling, and few life-cycle assessments are all serious safety and oversight issues that must be addressed, particularly because the potential long-term negative effects of nanotechnology in humans and the environment remain unclear.

Since developments in nanotechnology are expected to become a key, transformative technology of the 21st century, China, the United States, and the rest of the world have the opportunity to work with industry, government, NGOs, and the general public to ensure that nanotechnology's benefits are maximized and that risks are minimized right from the start.

Louise Yeung is a student at George Washington University and an intern "alumna" of the China Environment Forum; she can be reached at: lhyeung125@gmail.com. Evan Michelson is a research associate at the Project on Emerging Nanotechnologies at the Wilson Center; he can be reached at: evan.michelson@wilsoncenter.org.

NOTES

1. LuxResearch. (2005). "The U.S., Japan, South Korea, and Germany dominate in nanotechnology today—But Taiwan and China are rising," [Online]. Available: www.luxresearchinc.com/press/RELEASE_Nation2.pdf.

2. Hillie, Thembala; Munasinghe, Mohan; Hlope, Mbhuti; Deraniyagala, Yvani. (2006). *Nanotechnology, water and development*. Meridian Institute. [Online]. Available: http://www.merid.org/nano/waterpaper.

3. Nanoforum. (2006). *Nano and the environment*. [Online]. Available: http://www.nanoforum.org; Singer, Peter; Salamanca-Buentello, Fabio; & Daar, Abdallah. (2005). "Harnessing nanotechnology to improve global equity." *Issues in Science and Technology,* Summer; Court, Erin; Daar, Abdallah; Persad, Deepa; Salamanca Buentello, Fabio; & Singer, Peter. (2005). "Tiny technologies for the global good." *Nano Today*, April/May.

4. National Center for Nanoscience and Technology. (2005). *Self-assembled ZnS nanoporous nanoparticles as efficient semiconductor photocatalysts.* [Online]. Available: http://www.nanoctr.cn/e_view.jsp?tipid=1120030886981.

5. Duncan Hewitt. (November 17, 2000). "China's environmental challenge." *BBC News*, [Online]. Available: http://news.bbc.co.uk/1/hi/in_depth/asia_pacific/1027824.stm.

6. UNESCO. (2006). *The ethics and politics of nanotechnology* [Online]. Available: http://unesdoc.unesco.org/images/0014/001459/145951e.pdf

7. Meridian Institute (2005). *Nanotechnology and the poor: Opportunities and risks*. [Online]. Available: http://www.meridian-nano.org/gdnp/paper.php.

8. Nanoforum. (2006). *Nanotechnology helps solve the world's energy problems*. [Online]. Available: http://www.nanoforum.org/dateien/temp/ER%20April%202004%20total.pdf?21062006050326.

9. *China Daily*. (October 3, 2003). "China's nanotechnology patent applications rank third in world." [Online]. Available: http://www.chinadaily.com.cn/en/doc/2003-10/03/content_269182.htm.

10. Product inventory available at: www.nanotech-project.org/consumerproducts.

11. ETC Group. (April 7, 2006). "Nanotech product recall underscores need for nanotech moratorium: Is the magic gone?" [Online]. Available: http://www.nanotech-wire.com/news.asp?nid=3156&ntid=&pg=37.