IT'S A SMALL WORLD AFTER ALL!

Daniel S. Murad
President

The ChemQuest Group, Inc.
Cincinnati, Ohio

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NANOTECHNOLOGY has evoked a level of excitement in the scientific and investment community at a grand scale. But is it deserving of the attention? And, how does it impact the adhesive and sealant industries?

The first vision of Nanotechnology is widely credited to the physicist Richard Feynman. In a 1959 speech titled “There's plenty of room at the bottom," he wrote: “What I want to talk about is the problem of manipulating and controlling things on a small scale … Why cannot we write the entire 24 volumes of the Encyclopedia Britannica on the head of a pin? … I am not afraid to consider the final question as to whether, ultimately in the great future, we can arrange the atoms the way we want; the very atoms, all the way down!"

It wasn't until 1974, however, that Norio Taniguchi coined the term “Naonotechnology” at the University of Tokyo.

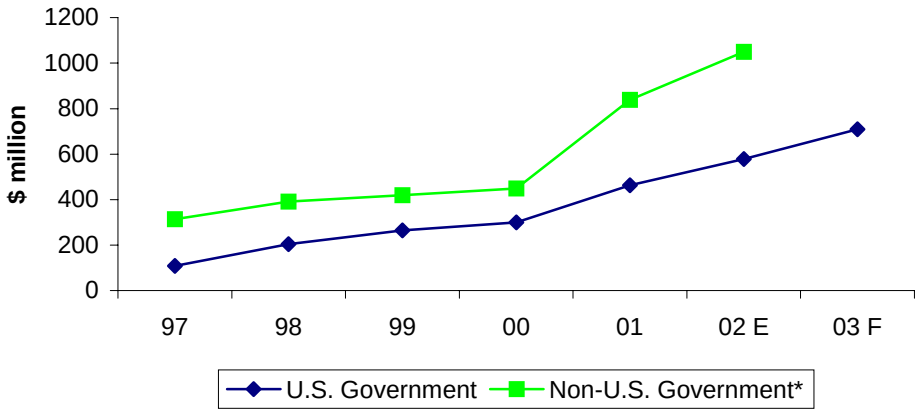
What is Nanotechnology? According to Interagency Working Group on Nanoscience Engineering and Technology (IWGN) at the National Science Foundation: “Nanotechnology is the creation and utilization of materials, devices, and systems through the control of matter on the nanometer-length scale, that is, at the level of atoms, molecules, and supramolecular structures.” Derived from the Greek word for midget, "nano" means 10^{-9}, a billionth part. In layman terms, that corresponds to one millionth the size of a pinhead, yielding perhaps the epitome of the definition of small.

As a technology, it is still in its infancy, but it may hold the potential to significant change. In its 1999 workshop with noted experts in the field, IWGN workshop contributors noted: “All natural materials and systems establish their foundation at the nanoscale; control of matter at molecular levels means tailoring the fundamental properties, phenomena, and processes exactly at the scale where the basic properties are determined. Therefore, by determining the novel properties of materials and systems at this scale, naonotechnology could impact the production of virtually every human-made object—everything from automobiles, tires, and computer circuits to advanced medicines and tissue replacements—and lead to the invention of objects yet to be imagined. Naonotechnology will be a strategic branch of

science and engineering for the next century, one that will fundamentally restructure the technologies currently used for manufacturing, medicine, defense, energy production, environmental management, transportation, communication, computation, and education."

The U.S. Government has been a leading proponent of this technology. The 2003 President's budget request, shown in Figure 1, of about $710 million for federal investment in nanoscale science, engineering and technology, is a 17% increase over 2002's nanoscale R&D budget appropriated by Congress of $604 million.

Figure 1
Naonotechnology Funding
* Includes private and foreign government spending
Sources: U.S. Senate Briefing



The National Science Foundation, Departments of Defense and spending dominate the spending appropriations with nearly eighty-percent of the budget, as can be seen in Table 1.

Table 1

Budget Appropriations by Government Agency for 2003

	% of Total
Department of Defense	28.3%
Department of Energy	19.6%
Department of Justice	0.2%
Department of Transportation (FAA)	0.3%

Environmental Protection Agency	0.7%
NASA	7.2%
National Institutes of Health	6.1%
National Institute of Standards and Tech.	6.2%
National Science Foundation	31.1%
US Department of Agriculture	0.4%

Three new R&D areas of focus are planned in all federal departments and agencies: manufacturing processes at the nanoscale, use of nanotechnology for chemical-biological-radioactive-explosive detection and protection, and development of instrumentation and metrology at the nanoscale.

As for the adhesive and sealant industry, we anticipate the impact will be felt in two areas- formulating with nano-based raw material polymers and additives as well as developing adhesion to nano-based substrates.

Several technologies that utilize the power of nanostructuring illustrate this point:

- Chemical companies are developing nanoparticle-reinforced polymeric materials that can replace structural metallic components in the auto industry. Widespread use of those nanocomposites could lead to a reduction of 1.5 billion liters of gasoline consumption over the life of one year's fleet of vehicles.
- The replacement of carbon black in tires by nanometer-scale particles of inorganic clays and polymers is a new technology that is leading to the production of environmentally friendly, wear-resistant tires.
- A long-term research program in the chemical industry on the use of crystalline materials as catalyst supports has yielded catalysts with well-defined pore sizes in the range of one nanometer.

  As the industry advances into higher tech applications replacing conventional fasteners, one of the challenges it faces is the ability to form a bond, as well as disassemble, on demand. Through naonotechnology, one can envision the use of smart-catalysts that can accomplish that objective.

- *In the construction materials area*, novel materials are being fabricated in which improved bonding and strength dependent upon the surface area and morphology of nanoscale constituents are leading to materials with enhanced strength and toughness for use in the construction and steel industries.

  Manufacturers and suppliers alike in the adhesive and sealant industry acknowledge the power and magnitude of implications from nanotechnologies in the coming years. Although R&D expenditures are still insignificant, most believe as the technology continues to gain momentum, it has the potential to dominate their development portfolio.

  Ultimately, of course, no matter how much is learned about the nanoscale and its properties, the industrial use of such materials will only come about if and when there is a definitive cost advantage for the end user.

About The Author

Dan Murad

President
The ChemQuest Group, Inc.,
an international strategic management consulting firm specializing in the Adhesives, Sealants and Coatings industries, headquartered in Cincinnati, Ohio.

Dan joined The ChemQuest Group, Inc. in 1996 from the Rohm & Haas Company where he was most recently European Director, Industrial Coatings. Prior to R&H, he spent thirteen years with Unocal Polymers where his career took him from technical service positions to Director of Marketing. He directed the sale of the Unocal Polymers Business to Rohm & Haas, working closely with Morgan Stanley, numerous attorneys, as well as the FTC. His entire career has been dedicated to the Coatings and Adhesives Industries. His particular strengths lie in strategic assessment and value creation on behalf of clients. He holds degrees from Wabash College (BS Chemistry) and William & Mary (MBA).
Contact Dan at (513) 469-7555 or dmurad@chemquest.com

Questions or request for additional copies of this paper may be directed to the author at:

The ChemQuest Group, Inc.
8150 Corporate Park Drive
Suite 250
Cincinnati, OH 45242

(513) 469-7555
(513) 469-7779 – FAX

www.chemquest.com