

# Nanotechnology Thriving on Patents

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**N**anotechnology is the science of materials and devices of nanometer size, approximately the size of a small molecule or individual atom. Nanotechnology is a multidisciplinary field, ranging from more durable metal coatings to more stain-resistant fabrics to Magnetoresistive Random Access Memories (MRAM) chips to sporting goods strengthened by carbon nanotubes (only one-sixth as heavy as steel but 100 times more strong). Additional products currently under development include small particles to increase drug delivery, manufactured neurons aimed at reversing paralysis, and compounds to prevent algae growth in swimming pools.

Estimates place the market for nano-engineered information storage devices at \$65.7 billion by 2011. MRAM, FRAM, holographic memory, ovonic unified memory, molecular memory, nanotube RAM, MEMS-based memory, and polymer memory will penetrate up to 40 percent of the storage devices market within seven years. By 2015, the global impact of products where nanotechnology plays a key role will be approximately \$1 trillion annually.

Due to the newness and breadth of nanotechnology, the United States Patent and Trademark Office (USPTO) categorizes nanotechnology primarily under a broad range of existing classifications. Primary areas of patent activity for nanotechnology include electromagnetic applications in class 250; semiconductor device and manufacturing applications in class 257 and 438; coatings in class 427; and a diverse array of biological chemical applications in classes 423, 428, and 435. Several USPTO classifications include a subclass for a specific type of nanotechnology, such as class 516/901 that encompasses substantially pure carbon such as graphite, lamp black, carbon black, and fullerene. Fullerenes are a molecular form of pure carbon and include structures like buckyballs and nanotubes. These two types of fullerenes are immensely strong conductive carbon structures that offer large receptive surface areas and promising commercial applications. The discovery of fullerenes, made in 1985, won the Nobel prize in chemistry in 1996.

The level of patent activity in the area of nanotechnology has increased dramatically

over the past seven years. According to the National Science Foundation (NSF), nanotech-related patents began issuing from the USPTO as early as 1976. The NSF estimates that several thousand have issued annually since the early 1990s, with a large spike between 1996 and 1997 from 2519 patents to 3623 patents. This trend has increased steadily with 6425 nanotech-related patents issuing in 2002, a number surpassed in 2003 according to the *Journal of Nanoparticle Research*.

Nanotechnology is reaching the brink of crossing the line from research and development into production and commercialization. Altair Nanotechnologies, Inc., in its shareholder update, stated that several of its patented creations are currently being tested for use in consumer products, including nano-zirconia, a substance being used to strengthen polymer-based dental fillings, and NanoCheck, a compound to prevent algae growth in swimming pools.

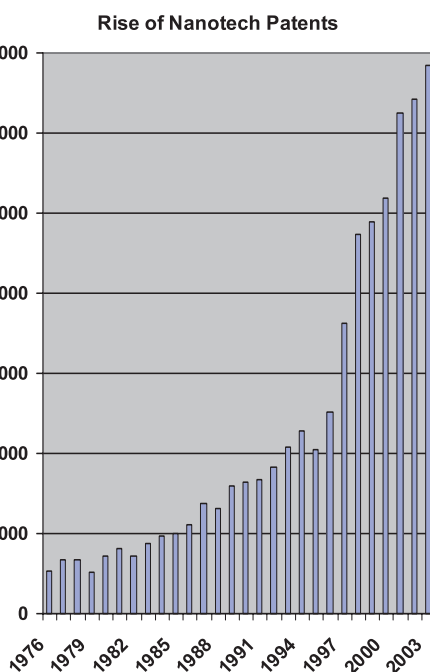
<b>Class 250</b>	Radio and Microwave Absorption Wavemeters
<b>Class 257</b>	Active Solid-State Devices (e.g., Transistors, Solid-State Diodes)
<b>Class 423</b>	Chemistry of Inorganic Compounds (includes Fullerene)
<b>Class 427</b>	Coating Processes
<b>Class 428</b>	Stock Material or Miscellaneous Articles (includes Fullerene)
<b>Class 435</b>	Chemistry: Molecular Biology and Microbiology
<b>Class 438</b>	Semiconductor Device Manufacturing Process

Altair expects to have the enhanced dental fillings available to the market by the fourth quarter of 2004 and the NanoCheck product available in the first quarter of 2005. The NSF estimates that nanotechnology could evolve into a \$1 trillion industry by 2015, providing roughly two million jobs worldwide. The Merrill Lynch Nanotech Index Report ventures that "nanotechnology could be the next growth innovation... the questions generally are of when, not if."

The majority of nanotechnology funding currently comes from the federal government. In December of 2003, President Bush approved a bill that will appropriate \$3.7 billion over the next four years for nanotechnology research and development. Many of the nanotechnology firms are privately owned ventures that survive on government funding. Such companies include Altair Nanotechnologies, Inc., which received a \$100,000 NSF grant this year for a six-month project, and NanoSonic, Inc., which has Air Force, NSF, and NASA

contracts. However, these grants are usually for specific research topics or goals, restraining the company to the government's needs and fiscal flexibility. Research-oriented universities such as Harvard, MIT, Arizona Board of Regents, and Regents of the University of California also provide immense funding for small nanotechnology firms. Other small nanotech ventures have paired with major companies, such as Intel and Motorola, for financial backing. For example, Air Products and Chemicals, Inc., a Fortune 5000 company, invested in Nanotechnologies, Inc., last year.

Spin-off ventures from universities and corporations are forming many of the leading nanotech companies. For example, Northwestern University Professor Chad Mirkin and his associates have formed two such companies from the fruits of their research: NanoInk, Inc., which received the first dip ink pen nanolithography patent, and Nanosphere, Inc., a life sciences nanotechnology company that holds several nanoparticle probe technology patents. NVE Corporation, now publicly traded on Nasdaq, is Honeywell's spin-off nanotechnology company.



Source: National Science Foundation and Journal for Nanoparticle Research

With the maturing of nanotechnology, nanotech firms are gaining more attention in the financial markets. As a significant indicator of nanotechnology's stock market potential, Merrill Lynch and Punk, Ziegel & Company both created nanotechnology stock indices in the spring of 2004, followed closely by other investment firms. The Merrill Lynch nanotech index (^NNZ) currently includes 24 nanotechnology-related companies in the fields shown in table below.

Punk Ziegel's 15 company nanotech index largely overlaps the Merrill Lynch index, but includes two other instrumentation companies: Nano-Proprietary, Inc., and MFIC Corp. Both Merrill Lynch and Punk Ziegel purposefully chose companies that rely on nanotechnology for a majority of their future profits. As a result, their indices do not include major corporations, such as Intel and Hewlett-Packard, that own numerous nanotechnology patents but are not "pure" nanotechnology companies.

A stock portfolio analysis of the companies listed on these nanotech indices shows a direct correlation between patent issuance and stock price surges. For example, NVE Corporation's (NVEC) stock rose from \$25.81 to \$36.43, or 41.15%, on the day its new MRAM patent was announced in June of this year, USP 6,744,086.

Nanogen's (NGEN) stock jumped over 50%, from \$3.79 to \$5.74, when it announced that it had received a patent for

technology that detects genetic variants, USP 6,753,148.

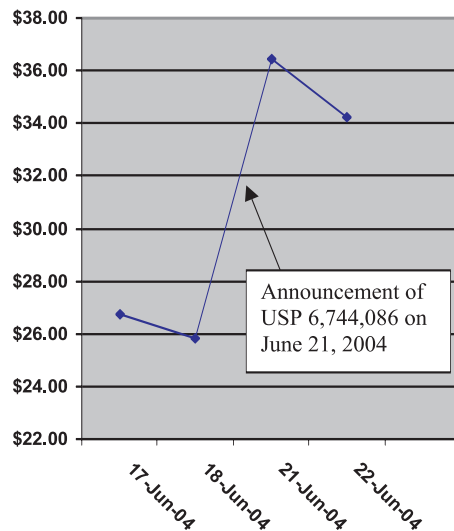
Some business experts, however, have thrown out a word of caution on nanotechnology: *dot com*. Like the Internet businesses in the late 1990s, some experts are warning that nanotechnology is overhyped and that nanotech stocks are surging on a bubble that is ready to burst. However, as Steven Milunovich, Merrill Lynch's global technology strategist, pointed out, nanotechnology differs from the recent Internet craze due to its serious patent and intellectual property barriers.

The patent portfolios of these emerging nanotech companies may protect these firms from the same fate as their dot com counterparts. Unlike Internet companies that valued their worth in the number of "hits" on their website, nanotechnology firms holding issued patents have real assets. Companies with these patented intellectual property assets own an exclusive niche in the market, a benefit that many companies in the dot com era lacked. Nanotechnology patents may prove the critical factor with investment strategies. The slow and deliberate patent process may give investors confidence that publicly traded companies holding nanotechnology patents are more stable investments than those without. As illustrated by several publicly traded nanotechnology companies, as well as the new nanotech stock indices, this correlation between patents and stocks may already have come to fruition.

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FIELD	ENTERPRISES
Biotech	Biosante Pharmaceuticals; Nanogen; Pharmacoepia; SkyePharma; Novavax, Inc.
Energy	Headwaters
Intellectual Property	NVE Corp.
Materials	Amcol International; Altair Nanotechnologies; Cabot Corp.; Symyx Technologies; Flamel Technologies; Nanophase Technologies
Nanotechnology Instrumentation	FEI Co.; Veeco Instruments; Acacia Research-Combimatrix; MTS Systems; Immunicon Corp.
Semiconductors	JMAR Technologies, Inc.; Kopin Corp.; Tegal Corp.; Ultratech
Venture Capital	Harris & Harris; Westaim Corp.

NVE Corp. Stock (NASDAQ: NVEC)



Nanogen, Inc. (NASDAQ: NGEN)

