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NANOTECH IP

As nanometer-scale materials start making money, intellectual property issues are heating up

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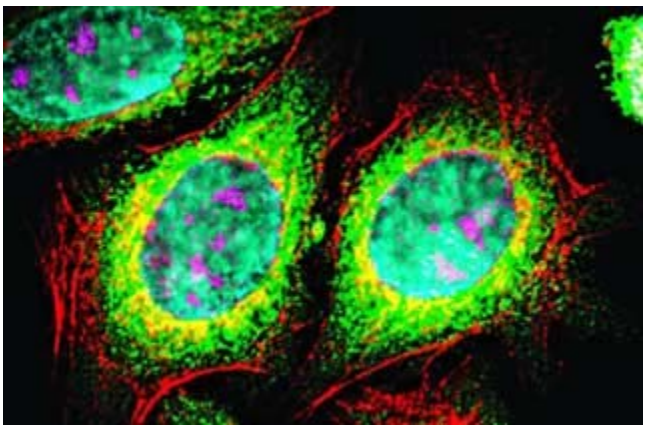


RAINBOW EFFECT Quantum dots allow simultaneous five-color imaging in fixed human epithelial cells for the first time. The colors allow localization of cellular proteins and substructures: The nuclei are stained cyan, Ki-67 cell proliferation proteins are magenta, mitochondria are orange, microtubules are green, and actin filaments are red.
QUANTUM DOT CORP.

Nanotechnology-the study of the unique properties of structures on the nanometer scale-is living up to its reputation as "the next big thing" in the scientific realm. Institutions and companies around the world are pumping billions of dollars into nanotech research, and investment continues to escalate.

Still a nascent field, nanotechnology promises to revolutionize manufacturing processes and products in almost any industry, including medicine, plastics, energy, electronics, and aerospace.

As nanometer-scale materials start making money, intellectual property issues are heating up

And although nanotechnology has already given birth to products both exciting and mundane, it promises to deliver countless more.

Estimating the commercial potential for such nanoproducts is nearly impossible both because many applications have yet to be conceived and because "nanotechnology is not, and never will be, an industry. It is a technology and no more an industry than physics or chemistry," says Tim E. Harper, chief executive officer of Científica, a nanotechnology consulting firm. But nanotechnology is expected to have a tremendous impact on the global economy.

Eager to get in on the ground floor, companies from start-ups to multinationals are aggressively locking up critical and basic nanotechnologies. They are racing to protect their own nanotechnology intellectual property (IP) or to license or buy it from universities, companies, or other groups.

Nanotech IP is particularly valuable right now because it is the foundation for a young and expansive field, notes Edward K. Moran, director of product innovation for Deloitte & Touche's technology consulting practice and leader of its nanotechnology practice. "Those buying nanotechnology IP have an opportunity not unlike getting into electricity or the automobile industry early and locking up

patents," he explains. In nanotechnology, "there's going to be unimaginable innovation [based on] these early discoveries. If you can claim a piece of that action going forward, that's good from an IP standpoint."

Having strong IP is important for companies building a base in nanotech. For start-ups in particular, "it's critical not only for protecting their turf, but also for attracting the financing they need to exploit their inventions," says Bryan Bockhop, a patent attorney with the Atlanta-based law firm Arnall Golden Gregory and cochair of the American Intellectual Property Law Association's nanotechnology subcommittee. "Without patents, it is very hard for them to convince a venture capitalist, for example, that there is much of a future in the company."

WORK IN PROGRESS Researchers at the Institute for Nanotechnology, Northwestern University, are making significant advances in the field of nanotechnology. Over the past two-and-a-half years, they have been responsible for more than 100 patent applications and 20 issued patents.
MATTHEW GILSON, NORTHWESTERN UNIVERSITY

BUT ASSEMBLING a strong IP arsenal has its pitfalls. To be successful, companies need to develop a thorough understanding of the patent landscape; monitor patent publications, issuances, licenses, and litigation; and develop concrete IP strategies that allow them to increase their chances of future profitability.

"A lot of nanotechnology companies are going out and locking up these little islands of intellectual property," Moran observes. "They grab a couple of promising but limited patents in a given area, and then they figure that they are ready to take in financing. Unfortunately, nanotech is so new and evolving so quickly that it is very difficult to lay bets on whether a little sliver of technology is ever going to turn into a commercial product."

Deep-pocketed manufacturing and venture-capital companies seem to have an affinity for nanotech platform companies—firms that pull together a broad portfolio of technology that is applicable across multiple markets, says Douglas W. Jamison, a vice president at "tiny tech" investment house Harris & Harris Group. "These platform companies," he adds, "are the ones most likely to become the foundation of the next generation of industries."

The best example of such a company may be Nanosys: the quintessential nanotech IP platform company. Through its three investment rounds, the company has raised more venture capital—$55 million—than any private nanotech company to date, Jamison observes. "And they've done that at a time when investors are very conservative. That speaks volumes about investors' confidence in Nanosys' IP position as well as in its management."

Since its inception in 2001, Nanosys has amassed an IP war chest of 200 patents and patent applications in the field of inorganic semiconductor nanomaterials such as nanowires, nanorods, and quantum dots—nanocrystals that shine brightly when excited by light. In addition to developing IP in-house, Nanosys has signed broad licensing agreements with key nanotechnology centers around the world, including Columbia University; Harvard University; Lawrence Berkeley National Laboratory; Massachusetts Institute of Technology; University of California, Los Angeles; UC Berkeley; and Hebrew University.

Stephen Empedocles, Nanosys' director of business development, declined to contribute to this article, saying, "We are not able to give interviews at this time." But company documents say Nanosys' business strategy is to commercialize its products through partnerships with leading companies in a variety of industries.

Through these relationships, one position paper states, "Nanosys leverages the market expertise and complementary technologies of our strategic partners, while our partners leverage the unique technical and market opportunities enabled by nanotechnology without having to become nanotechnology experts themselves." Although products are probably two years away, the company's first business partnerships are in photovoltaics, high-performance macroelectronics, chemical and biological sensors, and nanostructured surfaces. Nanosys has set up multi-million-dollar deals with companies including Intel, DuPont, and Matsushita Electric Works.

Multinational Degussa is another company that counts partnerships as a critical element of its nanotech strategy. "It is essential to set up and maintain strategic alliances with companies having complementary IP positions," says Markus Pridöhl, senior manager for R&D at Degussa Advanced Nanomaterials, which operates as an internal start-up company.

Rainer Hahn, senior manager for marketing at the Degussa unit, notes that, in many cases, the use of a novel nanomaterial is covered by a patent from a company that possesses application know-how but doesn't have access to the best material source. "The combination of the best material IP with the best application IP is the key to commercial success for both alliance partners," he says.

For the mutual benefits they provide, "we are going to see a lot of nanotech start-ups entering into these types of arrangements," Moran predicts. "You won't see them coming out and going public. Instead, a lot more will be working quietly with big companies providing them with IP and expertise that they need."

NANOTECH START-UPS will also continue to provide that IP through licensing agreements. However, when the IP is going to be applied to an as-yet-unproven or unknown commercial market, setting the value of the agreement can be tricky, Harper observes. "It can be harder to convince potential licensees of the value until it is further developed."

In addition to partnering and licensing, many companies are shoring up their nanotech positions by protecting their own internal IP—a strategy that can be more complex than it is in other disciplines. In nanotechnology, patents are not always the best way to protect IP, Bockhop explains.

Patents are an obvious choice for protecting most macroscale inventions that can be disassembled or reverse-engineered. In those cases, a company need not be reluctant to reveal the details of its process to its competitors in the form of a patent or patent application, because competitors are likely to figure it out on their own anyway. And a U.S. patent excludes others from using the process for 20 years from the patent application's filing date.

But inventions on the nanoscale are more difficult to "take apart," Bockhop points out. In some respects, he says, "they are like a house of cards; if you pull one critical card out, the whole thing collapses. In these large, complex molecules, each atom is influencing the stability of the entire molecule," he adds. "So rather than patenting a nanotech invention and telling the whole world how to make it, it often makes sense to protect it as a trade secret."

However, taking the trade secret route makes sense only if a company has a corporate environment that maintains secrecy. "If every employee knows how the whole invention works and you don't have ways to compartmentalize different steps in the process, then it would be very hard to maintain secrecy relating to the invention," Bockhop says. "And, unfortunately, with trade secrets, once the cat is out of the bag, it's hard to get it back in."

The selective use of trade secrets notwithstanding, companies still protect much of their IP the old-fashioned way: with patents. The number of nanotech patents issued has soared since the 1980s, when the discipline of nanotechnology was first conceived. In 1985, approximately 250 new nanotechnology patents were filed, but by 2003, that number had increased to more than 5,500, according to figures from Thomson Derwent, a scientific information consulting firm.

That growth has occurred despite a number of significant obstacles to patenting nanotechnology. For one, the cross-disciplinary nature of nanotech makes it difficult to write patents that give full measure of protection to inventions, Bockhop says.

For example, "you might have an invention that involves bombarding an organic molecule with photons and then applying an electric current," he says. "It is hard to tell whether to characterize the invention as chemical, optical, or electrical." The attorney who is writing the patent is challenged to "overcome his or her own technical bias to see the broader invention. It's important to find a way to perceive it across technical lines and then claim it in such a way that you maximize protection."

To deal with this issue, a growing number of IP law firms are creating cross-disciplinary teams of physicists, materials scientists, electrical engineers, and chemists who are also attorneys and patent agents. "We can talk science to inventors, while we advise management on the best strategies to follow in this increasingly competitive environment," says Ronald L. Grudziecki, a senior partner and member of the nanotechnology team at the Alexandria, Va.-based law firm Burns, Doane, Swecker & Mathis.

REACTOR At Degussa Advanced Nanomaterials' Hanau, Germany, site, this hot-wall reactor is used in the R&D department for process development. DEGUSSA ADVANCED NANOMATERIALS

THE CROSS-FUNCTIONAL nature of nanotechnology is also creating challenges for the U.S. Patent & Trademark Office. Currently, PTO is organized into seven different technology centers from biotechnology to chemistry to materials engineering, but none is specifically dedicated to nanotechnology. For now at least, PTO is able to successfully process applications by channeling them into its existing examining groups, says Bruce Kisliuk, PTO's director of biotechnology.

But this isn't the first time PTO has had to deal with cross-disciplinary patent applications, Kisliuk points out. Back when applications in bioinformatics started to come in, for example, the office had to bring together examiners and supervisors from both the biotech and computer groups.

PTO has no immediate plans to create a nanotechnology examining group. But as the number of nanotech patent applications continues to rise, the office may "have to reorganize or restructure in a way that ensures that the number and organization of examiners and their supervisors are

appropriate to these new technologies," predicts Q. Todd Dickinson, former PTO head. Now a partner with the law firm Howrey Simon Arnold & White, Dickinson will become vice president and chief intellectual property counsel at General Electric in May.

For the moment, PTO is responding to the new demands of nanotechnology in other ways. For example, it has a project under way to establish a cross-reference art collection, in which it assembles nanometer-scale prior art (R&D conducted in the area previously) into searchable categories in the PTO patent classification system. Dickinson applauds the move, noting that the collection will "eventually be used for building the main search tools for nanotechnology."

PTO is also reaching out to industry to better educate its examiners about the science. Grudziecki observes that patent examiners typically make up about half of the 80 to 120 people who come to hear prominent nanotech speakers at the monthly meetings of the Atlantic Nano Forum, a nonprofit networking and education group set up to help improve patent quality.

And PTO has launched a series of Nanotechnology Customer Partnership meetings designed to be a forum to seek individual opinions and feedback on issues regarding nanotechnology, according to Kisliuk. The first meeting, held in September, had more than 80 attendees. The second one will take place on April 20.

Industry players have a vested interest in educating PTO on nanotechnology. One major challenge will be convincing the office that nanotech inventions "are not merely known technologies done on a different scale," which does not ordinarily justify patentability, Dickinson says. It's important to be able to demonstrate "nonobviousness"—that the more conventional laws of physics change when you get down to the molecular and atomic level, for example, he says.

And prospective patentees want to be sure that examiners are well-equipped to set reasonable boundaries and prevent unwarranted overreaching at this stage in the nanotechnology game. If PTO awards too many broad, concept patents, it might allow certain companies to lock up huge areas, thereby stifling innovation. The issuance of poorly drafted patents could plague the nanotechnology field, leading to expensive and time-consuming legal battles.

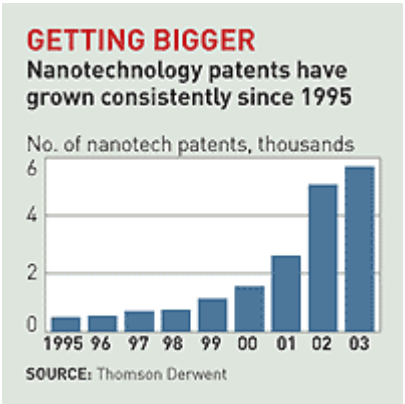
But for now, companies seem to want to avoid fighting over patent turf even though they might have grounds to do so. "There's not a lot of litigation going on yet in nanotechnology, which is curious, because it's not difficult to find examples of one company's IP bleeding into another's," Moran says.

It may be that patentees are avoiding litigation in the interest of expanding the market for nanotechnology. "Maybe taking legal action that would put some cutting-edge firms out of business isn't going to help their own long-term prospects. The last thing that they may want to do is put a chilling effect" on the development of market applications, Moran conjectures.

This may explain the lack of litigation going on in the carbon nanotubes arena, in which companies are just beginning to lay claim to areas of IP.

Early last month, Japan's NEC essentially claimed a monopoly, saying it owns basic patents on carbon nanotubes that must be licensed by any company wishing to pursue the graphite material. NEC said one of its senior researchers, Sumio Iijima, discovered carbon nanotubes in 1991, and that it holds two essential patents on the technology. NEC announced that it has signed an agreement with Sumitomo Corp. granting Sumitomo a nonexclusive license under basic Japanese patents owned by NEC that cover carbon nanotubes.

Other companies working in the carbon nanotube area, such as Houston-based Carbon Nanotechnologies Inc., are not using their resources to challenge patent rights. Instead, CNI has effectively licensed the technology through Sumitomo, its agent in Japan, and from IBM, which has claims in the U.S. comparable to NEC's. "We have acted as if some claims are valid because we don't want to fight about it," says Bob Gower, president and chief executive officer of CNI. "One could argue that single-wall nanotubes were discovered much earlier than NEC claims, but that really isn't the issue we think is important at this stage."



CNI is focused on developing its own IP, which is oriented toward production of carbon nanotube derivatives. In February, the company announced the issuance of a key patent on technology for linking carbon nanotubes to each other and to other species and substrates, "greatly enhancing the potential of carbon nanotubes and broadly expanding their range of end uses," Gower says.

Gower anticipates that carbon nanotubes will find commercial application-on a modest scale-this year. They will likely be products that take advantage of carbon nanotubes' electrical conductivity or

their ability to improve strength in applications such as in sporting goods, he says. In anticipation, CNI is scaling up production at its plant in Houston, hoping to reach 100 lb per day around midyear.

Although companies today seem content to avoid litigation in the interest of market development, that's not likely to be the case for long. If nanotechnology tracks other emerging technologies, patent litigation is in its future, Dickinson predicts. As new players come in, "they sometimes either focus too much on obtaining patents or they ignore the patents of others, expecting to clean up any conflicts later. People need to be forewarned now. There will be a lot of frustration and gnashing of teeth."

Jamison reaches the same conclusion, drawing a parallel with both the biotechnology and semiconductor industries, which experienced a "huge rise in litigation after producers had established a market and began to make money."

Eventually, "people are going to find that they are all doing the same things. And then the leaders, who made major investments, are going to be required to protect their technology," says Ken Barovsky, vice president and intellectual property counsel for Quantum Dot Corp., a company focused on semiconductor nanocrystal technology and its application in biology. The strength of patent portfolios will be what separates the winners from the losers, he adds.

"I know that there are companies that are practicing some of the quantum dot arts without the benefit of having secured any kind of patent of their own," Barovsky says, noting that Quantum Dot now has 137 patents issued or pending. When these companies commercialize their products, "that's when we will see more jockeying going on."

From entrepreneurs to researchers, everyone involved in the nanotech arena is focused on IP and how it will affect global competitiveness.

Surprisingly, Europe, Japan, and the U.S. have invested comparably in micro- and nanotechnology. "The U.S., I think, is going to have an interesting time adapting to a world in which it doesn't own the cards," Harvard University chemistry professor George Whitesides said last month while attending the Kyoto Laureate Symposium in San Diego. There, he received a prize for his work in organic molecular self-assembly, which has applications in nanotechnology. "It has been possible to assume that the technology that drives business is there on the shelf and that [the U.S. has] the chance to own it. It's much more competitive in the future."

"A race has started," Degussa's Pridöhl notes. "The U.S. and Japan are expected to have the cars with the faster engines due to the strongly increased public funding for nanotechnology research. But in this competition, Europe, especially Germany, may have a pole position. Therefore, determining who will ultimately win the race is a matter of timing, IP position, marketing strategy, and effective partnership."

To be sure, many companies around the world want to find a way to cash in on nanotechnology's future prospects. "Doing the research and speaking to people in nanotechnology, you can see the financial and economic importance that it is going to have for companies, for the economy, and for countries in general," Moran says. "It's really setting the stage for a new industrial revolution."

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