

Issue 49: November 2007

Nanotech & Green Building

When you think of nanotechnology do you think of green building? Probably not, but nanotech, the manipulation of matter at the molecular scale, is already providing environmental benefits for buildings.

Although the market for nano-enhanced building materials in the U.S. was under \$20 million in 2006, it's expected to grow to \$400 million by 2016. \$4 billion a year is being pumped into nanotech R&D worldwide, resulting in a pipeline of materials and products that will transform the way future buildings are made.

Nano has the potential to greatly reduce emissions from buildings - which produce 43% of the world's CO₂ emissions - reduce construction waste, which accounts for 40% of landfill materials, while providing cleaner air and water inside buildings.

In the first wave, nanotech is making its way into insulation, coatings and solar PV. The next wave, currently in the development stage, will bring advances in lighting technology, air and water purification. In about ten years we'll begin to see changes in structural components like concrete and steel, adhesives, and batteries.

We interviewed George Elvin, who recently published the fascinating report, "Nanotechnology for Green Building," which identifies 130 startups and established companies offering or developing nanomaterials for green building. Elvin is director of the Green Technology Forum and Associate Professor at Ball State University.

PI: How is nano being used today in green building and who are the leading companies?

George Elvin:

Using nano to improve the performance of existing buildings is one of the great opportunities right now.

Nano insulation is one of the most commercialized nano products. It gets around the problem of insulating existing buildings, which is hard to do with bulky conventional materials like fiberglass. You literally paint or spray the insulation on - it's invisible and non-toxic. The insulating coatings are so thin and clear that you don't know they're there.

With demand for energy efficient buildings rising, insulation is the most cost effective way to reduce carbon emissions from buildings - it lowers a building's energy consumption by 42% while maintaining a comfortable indoor environment. Nano insulating materials are about 30% more efficient than conventional materials like fiberglass or cellulose.

Industrial Nanotech (INTK.PK), for example, is signing multi-million dollar contracts right and left. They also insulate pipelines - the coating insulates them from the weather, saving huge amounts of energy. In an example of another application, they just signed a big contract with the largest textile company in Turkey to coat some of their machinery. When you insulate machinery, the building's cooling costs drop dramatically. It's being applied to aluminum ceiling panels in the new Suvanabhumi International Airport in Bangkok, the world's largest airport.

The company is developing the first prototype for insulation that actually generates electricity. The thin sheets of insulation - just a few thousands of an inch thick - use the temperature differential that insulation creates to generate electricity. In the future, they will be able to tap the difference in day and night time temperature between the inside and outside of a building, an almost constant source of energy.

Important emerging companies include **Industrial Nanotech** (Naples, Florida), **Nanotec** (Brookvale, Australia), **Ecology Coatings (ECOC.OB)** (Bloomfield Hills, Michigan) and **Aspen Aerogels** (Northborough, Massachusetts).

It's interesting to see these young companies coming out of the labs and into the market. They often start when a scientist finds some amazing properties in the lab and builds a product around it, and then finds a business partner to start a company around the product.

Cabot Corp (NYSE: CBT) is a midcap company that makes aerogel insulation. It doubles the insulation and light transmission values of skylights and other daylighting technologies, enabling architects to design buildings with more natural light (reducing energy consumption).



Aerogel, dubbed "frozen smoke," is the lightest weight solid in the world. The gel is filled with gas rather than liquid and is 95% air. Yet, it can support over 2,000 times its own weight. An 3.5 inch thick aerogel panel provides an R-value of R-28, previously unheard of in a translucent panel.

PI: How is nano used for coatings?

George Elvin:

That's the other most established sector. Nanocoatings can be used to self-clean surfaces, and in the process they de-pollute - they actually remove air pollutants and dissolve them into relatively benign elements.

De-polluting nanocoatings break down toxins that come in contact with surfaces. When painted onto a road, bridge or building they not only protect the surface and reduce the need for cleaning, they eliminate some of the pollution that cars emit. It's invisible and nontoxic.

Nanotec's coatings are on a number of buildings around the world now. A building stays clean much longer, especially the windows, reducing the need for toxic chemical cleansers which emit volatile organic compounds (VOCs). They also have the potential to clean indoor air.

Self-cleaning windows were one of the first architectural applications of nanotech. The coating causes water to sheet off the surface, leaving a clean exterior with minimal spotting or streaking.

Kohler and other plumbing fixture manufacturers are starting to paint anti-microbial coatings on sinks and toilets, which means less maintenance and lower costs. **Microban International** makes a product called Microban, which is used in 450 products including cleaning supplies, paints, caulking and plumbing fixtures.

In the future, the technology could make pipes so smooth and slippery that they can't plug up, wear out, and can carry much more water in a smaller pipe.

PI: What's happening in solar?

George Elvin:

Nanotech solar is starting to offer real competition to conventional silicon-based solar manufacturing. It isn't as efficient as conventional solar, but is steadily improving. It could replace silicon technology in 5-10 years. The Department of Energy estimates that 50% of the electrical needs of buildings in the U.S. can be met by BIPV systems.

NanoSolar has received \$100 million in investments from some of the venture capital powerhouses, along with individual investors like the founders of Google. The company has the potential to transform the solar market with its "roll to roll" process, where thin film, nanotech solar cells are literally printed onto plastic or metal. It makes integrating solar into a building more like printing a newspaper, a major advance from glass plates that are installed on rooftops.

Solar sheets can be made for about a tenth of what current panels cost at a rate of several hundred feet per minute. When full production starts in early 2008, NanoSolar says it will produce 430 MW of solar cells a year. Its SolarPly BIPV panels, made from semiconductor quantum dots and other nanoparticles, will create solar-electric "carpet" to be integrated into commercial roofing membranes.

Spire, Innovalight, Konarka, HelioVolt and Solexant are other important nano solar companies all involved with building integrated PV solar (BIPV). **STMicroelectronics (NYSE: STM)** is a large cap company that's developing nanotech applications for new solar cell technologies [editor note: STM was on our SB20 List for several years].

Spire Corp (Nasdaq: SPIR) integrates solar into façade elements like windows and awnings. Its nanostructured materials make fabricating solar cells more efficient and enables solar to be available in various colors, giving architects options for improved aesthetics.

Innovalight is developing silicon ink-based printed solar cells. By processing silicon with liquids, the company believes it can reduce the cost of solar by over 50%. The founder, Alf Bjorseth, is the former CEO of Renewable Energy Corp (REC), one of the world's largest vertically integrated solar companies. The recent capital raise of \$28 million should move Innovalight from development to production.

PI: What's happening in lighting?

George Elvin:

LED lighting is already a \$4 billion market, and organic LEDs (OLED) are coming soon. It's a potentially huge market with a lot of money going into research. In the long run - at least 10 years off - we're looking at exciting developments that will change the relationship between lighting and building.

OLEDs are like thin film solar in that they are printed onto substrates. When activated by electricity, they provide brighter, crisper displays on electronic devices and use far less energy than LEDs. TVs will be less than ¼ inch thick and will be able to be rolled up when not in use. OLEDs can be applied to any surface, flat or curved, to turn it into a light source. In the future, light panels will replace light bulbs - walls, floors, ceilings, curtains, cabinets and tables could all become sources of light.

They are beginning to appear in small consumer devices like cellphone screens and are starting to enter the architectural lighting market.

Universal Display Corp (Nasdaq: PANL) is an important company here. **Philips (NYSE: PHG)** [Editor Note: on our 2007 SB20 List] and **GE (NYSE: GE)** are picking up the technologies.

PI: Tell me about some of the areas that are further in the future.

George Elvin:

Think about all the applications that can benefit from greater efficiency and you'll find a role for nanotech. It will make batteries more efficient, create new supercapacitors, lead to advances in thermovoltaics for turning waste heat into electricity, create improved materials to store hydrogen, as well as more efficient hydrocarbon based fuel cells.

Altair Nanotechnologies (Nasdaq: ALTI) is one of the most established companies that's developing batteries - their NanoSafe product will be used in the new line of electric Phoenix motorcars. AlwaysReady, a subsidiary of **mPhase Technologies (XDSL.OB)**, is bringing its Smart Nanobattery to market.

Nanotechnologies for water and air filtration, which are widely available as consumer products, will increasingly penetrate the market for built-in filtration systems. **Donaldson Company (NYSE: DCI)** is active in this area. **NanoH2O**, a development stage company, is creating advanced membrane materials for the desalination and water reuse industries.

NanoDynamics is another interesting company that's involved in a wide range of nano applications like water purification, coatings, fuel storage and batteries. It's planning an IPO on the Dubai exchange.

Research is also underway to use nano for fire protection and to enhance structural materials including steel, concrete and wood.

PI: Are you concerned about any safety issues with nanotech?

George Elvin:

Nanoparticles are more readily absorbed into the body than larger particles - unfortunately, little is known about how they accumulate in the body or the environment. Silver nanoparticles, which are proven antibacterial agents and are incorporated into many nanotech paints and coatings, are subject to the first EPA regulations in the field. There are concerns that nanosilver might accumulate in the environment, killing beneficial bacteria and aquatic organisms.

There are also questions about how employees in nano manufacturing plants may be affected. A recent study showed cancer-causing compounds, air pollutants and toxic hydrocarbons associated with carbon nanotube manufacturing. Four major U.S. nanotube producers are developing strategies for environmentally sensitive production.

You've been absorbing titanium dioxide nanoparticles for years through your sunscreen - it's used in many cosmetics and other dermal applications to make white particles disappear into the skin.

DuPont and Environmental Defense are some of the company/ NGO partners working together to develop regulatory policies.

Other factors also stand in the way of widespread adoption. The cost of many nanotech products and processes are still high, and the building industry has always been slow to adopt new technologies. The lack of independent testing and the current reliance on manufacturer claims of architectural and environmental performance is also a problem.

Nanotechnology for green building will reduce waste and toxicity, as well as energy and raw material consumption in the building industry, resulting in cleaner, healthier buildings.

I think those that adopt nanotech for green building will emerge as leaders and be rewarded accordingly for their services. And for nanotech companies, green building is one their largest markets.

++++

"Nanotechnology for Green Building" report is available at:

<http://www.greentechforum.net/greenbuild>

Public Companies	Ticker	Product	Location	Price Range
Industrial Nanotech	INTK.PK	Coatings	Naples, FL.	0.17 0.13 - 0.26
Ecology Coatings	ECOC.OB	Coatings	Bloomfield Hills, MI	1.60 2.00 - 6.00

Cabot Corporation	NYSE: CBT	Coatings	Boston, MA	33.80	30.44 - 49.87
Spire Corp	Nasdaq: SPIR	Solar	Bedford, MA	18.82	7.63 - 19.41
STMicroelectronics	NYSE: STM	Solar	Geneva, Switzerland	15.36	14.91 - 20.84
Universal Display Corp	Nasdaq: PANL	Lighting	Ewing, NJ	17.00	11.97 - 19.66
Philips	NYSE: PHG	Lighting	Amsterdam, Netherlands	42.05	35.35 - 45.90
Altair Nanotechnologies	Nasdaq: ALTI	Batteries	Reno, NV	4.22	2.48 - 5.45
mPhase Technologies	XDSL.OB	Batteries	Norwalk, CT	0.079	0.04 - 0.27
Donaldson Company	NYSE: DCI	Air Purification	Minneapolis, MN	46.24	33.60 - 46.29
NanoDynamics	IPO soon	Various	Buffalo, NY		

Private Companies

Nanotec	Coatings	Australia
Aspen Aerogels	Coatings	Northborough, MA
Microban International	Coatings	Huntersville, NC
NanoSolar	Solar	San Jose, CA.
Innovalight	Solar	Santa Clara, CA.
Konarka	Solar	Lowell, MA
HelioVolt	Solar	Austin, TX
Solexant	Solar	San Jose, CA
NanoH2O	Water Filtration	Los Angeles, CA

THE END