International Fiber Journal
June 15, 2004

Infant Nanotechnology Industry Searches for Big Opportunities
(excerpt)
By Michael Cole

While the internet craze dominated much of the 1990s landscape, the potential of nanotechnology-the science of manipulating materials billionths of a meter- has received a similarly enthusiastic response in current times.

Its loudest proponents claim that nanotech-derived products may someday cure disease, slow the aging process, eliminate pollution and lead to revolutionary advances- many within the fiber industry. The National Science Foundation has predicted nanotechnology will grow to be a $1 trillion industry by 2015.

The buildup over nanotechnology, fueled by large government endowments and intensive R&D projects, is even apparent in a popular commercial showing a nanotechnology professor winning over a famous swimsuit model. While many tout the potential of nanotechnology, others, wary from the recent burst of the dot.com bubble, have tempered their optimism. Amid the debate, there is overall consensus that nanotechnology, a science still in its relative infancy, has yet to fulfill its promise.

Definition Debated

The lingering confusion surrounding nanotechnology is evident in the fiber industry, which still seeks a universal standard to define the size of polymeric nanofibers. When referring to fibers, "nano" refers to the diameter of the fiber. Generally speaking, nanofibers have diameters less than one micron and cannot be seen without visual amplification. While nanofibers have a diameter between 50 and 300 nanometers, a cut-off pint is still debated, as some believe that fibers up to 500 nanometers could be classified accordingly.

While many potential markets are being discussed for polymeric nanofibers, only one application-filtration- has established a proven track record.

"That certainly has been the first point of commercialization," said John Hagewood Ph.D., business unit director of Hills Inc., a West Melbourne, FL, manufacturer specializing in bicomponent spinning technology and equipment for the production of nanofibers.

"I believe there are two other levels we'll reach in the future. The second area will be barrier fabrics that will incorporate a nanostructure between layers of clothing that will filtrate and encapsulate particles that neutralize chemicals or microbials to kill germs or viruses. This will be similar to the first area, filtration.

"The third application will be for textiles such as high-tech cloths, where the size of the fibers is smaller than a wave length of light, for instance. You'll be able to create cloths that can even polish optical fibers." Dr. Hagewood said.

In nanofiber air-filtration technology, Donaldson Co. is clearly the recognized leader. Using advanced electrospinning processes the Minneapolis-based company has produced 0.25 micron diameter nanofibers for air filtration applications for more than 20 years.

The typical electrospinning process uses an electric field to draw a polymer melt or solution from the tip of a capillary to a collector. A voltage is applied to the polymer which causes a jet of the solution to be drawn toward a grounded collector' the fine jets form polymeric fibers that can be collected on the web.

Our dramatic breakthrough came in 1981, when we became the first to use electrospinning to make filter media on the production line," said Timothy Grafe, Donoldon's director of nanofiber media products. "Our first product was a filter for industrial factory filtration."

Today, Donaldson remains specialized in filtration applications for factories, power plants and vehicles, such as tractors and bulldozers, that operate in dusty conditions. Among its latest breakthrough developments is the creation of self-cleaning nanofiber filtration unit for the Army's A-1 tanks operating in Iraq.

Beyond Filtration

The military has long been interested in the development of nanofibers, and current efforts are on going to apply nanofibers to high-tech clothing that is biologically and chemically protective.

"We're not there yet," said Heidi Schreuder-Gibson, PH.D., a polymer chemist at the US Army Soldier Systems Center in Natick, Massachusetts. "We have found that if we electrospin polymers that have good elasticity we can achieve the durability and flexibility that we want, but we need to improve the bond strength between the membrane and the fabric and that strength between the fibers."

Dr. Gibson said her efforts attempt to combine the clothing system's protective properties with a comfort level similar to that of Gortex.

"There are still a lot of technical issues that have to be resolved," she said. "what I'm asking myself right now is, if I put electrospun fibers into clothing systems, am I getting a performance advantage that is worthwhile?"

While the Army's studies continue to search for that answer, an advanced materials company is discovering a satisfyingly affirmative response as it produces nanotech-related treatments for the everyday fabric industry.

Nano-Tex, LLC, based in Emeryville, California, has weathered the bankruptcy storm of its North Carolina parent company, Burlington Industries Inc., in introducing three types of fabric enhancements that promise spill resistance, wicking and moisture management, and soft synthetic comfort similar to cotton.

The treatments offered by the 6 year-old start uphave been adopted by more than 40 apparel and interior furnishings brands, including Eddie Bauer, Gap, Old Navy, Lee, Nike, receiving praise along the way from Time magazine through its top invention award.

According to **Nano-Tex**, the proprietary treatment does not involve the use of coatings' rather, the fabric is dipped into a treatment that adds nano-sized whiskers that are one million times smaller than a grain of sand, which permanently attach to the fabric.

"With our application methodology, the product goes into a vat, gets saturated and is placed in a curing oven," explained Renee Hultin, president of Nano-Tex's North American division. "The heat causes a chemical reaction between the chemistry and the fabric. What we apply to the fabric is approximately 50-100 nanometeres in size."

While her company is exploring alternative applications for its technology, Nano-Tex initially focused on penetrating the everyday clothing market, Ms. Hultin said.

"We could have gone a million directions," she said. "We felt this was our opportunity to bring an innovative type of technology into a market that hasn't seen innovation in a long time. When you think about it, there really has not been a lot of R&D in this industry for 20 years, as companies have moved offshore. We've been successful in marrying the R&D with a business and sales background in textiles."