



Tiny carbon tubes help save energy

Nanotubes **take off**

Carbon nanotubes not only improve the performance of lithium-ion batteries and are used in fuel cells; they also increase the energy yield of wind turbines. Now Baytubes® nanotubes from Bayer MaterialScience could even enhance the effectiveness of climate protection efforts by making aluminum nearly as hard as steel and thus enabling the construction of ultra-lightweight, fuel-saving cars and planes.

Some of the most industrious contributors to climate protection are invisible to the naked eye: Baytubes® carbon nanotubes (CNTs) measuring just a few nanometers have – almost literally – been lending wings to wind power since fall 2008. The nanoparticles are the basis of the highly efficient wind power systems manufactured by Eagle Windpower of Finland. “The high strength of the nanoscale tubes made it possible to design blades for the Finnish systems that are two-and-a-half meters long

and so lightweight they generate energy efficiently even in low winds,” explains Dr. Raul Pires, Head of Global Baytubes® Business Expansion at Bayer MaterialScience. The rotors can turn even a light breeze into a significant amount of electrical power, yet withstand hurricane-strength wind speeds. “The power yield increases by nearly a third,” Eagle engineers maintain. In chemical terms, the tubes are made of the same material as, for example, pencil leads, namely pure carbon. Only their atomic structure

makes the crucial difference: the carbon atoms in Baytubes® form a multi-layered tubular wall that is a uniform honeycomb lattice. “It’s an extremely stable structure and chemically almost indestructible,” Pires says. Baytubes® are sold as a coarse, black powder, however, with each grain containing many thousands of nanotubes tangled in bundles, just like the wires in steel wool.

Bayer MaterialScience is currently building one of the world’s largest production plants for the manufacture of

Interview



“No alarming reactions”

How safe are CNTs? *research* spoke to Dr. Uwe Vohrer, an expert in CNT characterization and safety research at the Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB) in Stuttgart.

Can carbon nanotubes be harmful to health?

Unfortunately there is no universal answer to that question, because not all nanotubes are the same. Manufactured products simply differ too greatly, for example in terms of the length and diameter of the tubes, or the catalysts used in production. For Baytubes®, however, current research shows that a risk to man and the environment from CNT agglomerates can be ruled out almost entirely. A toxicologist would never say the risk is zero, because even table salt can be toxic if you swallow large amounts of it.

How safe are products containing nanotubes?

Nanotubes are very firmly bound in plastic composites. We have not found any free nanotube particles at all from such products.



Nanotechnology takes off. With their high strength and light weight, carbon nanotubes are the ideal material for state-of-the-art wind turbines, also for private roof-top installations (photo left). Baytubes® are supplied as a coarse black powder (photo center) which is soon to be produced in a large facility in Leverkusen, similar to the one pictured in the photo right.

carbon nanotubes in the Leverkusen Chempark. The new facility will have a capacity of 200 tons per year. The company is investing a total of €22 million in the planning, development and construction of the plant. “We are investing in a key technology for the future which is opening up a multitude of possible applications for us,” explains Dr. Wolfgang Plischke, the member of the Bayer Board of Management responsible for innovation, technology and the environment, at the start of construction work.

Aluminum: almost as hard as steel thanks to nanotubes

The tiny carbon nanotubes are also a business with huge potential: in about 10 years, the global market for the product will be worth some US\$ 2 billion.

CNTs are real powerhouses. They can bear much higher mechanical strain than steel at a fraction of the weight. They conduct heat better than diamond and electricity as well as copper. What’s more, carbon nanotubes offer enormous potential when it comes to climate protection, because in multi-wall form, they lend extraordinary properties to plastics, but also to aluminum. Soon they could make cars and planes even lighter and so help to save fuel. “The CNT-aluminum composite is at

most half as heavy but nearly as hard as steel,” says Professor Horst Adams from Bayer MaterialScience, who is rapidly advancing development of this new material. “Until now, we could only give aluminum extreme hardness and tensile strength by adding rare and expensive metals,” the materials specialist explains. Carbon nanotubes are an interesting alternative, and they have the potential to significantly increase the strength of conventional aluminum alloys.

The new Baytubes®-aluminum composite will likely compete not only with steel, but also with carbon fiber-reinforced plastic and titanium. For example, screws made of the composite are currently being tested in high-end mountain bikes, where they replace titanium. “Sports equipment is a good testing ground for new materials, because the benefits are visible sooner, and the results help us to develop other applications,” Adams says.

The Baytubes® used in plastic composites also began their career in sports, and it took them only five years to go from hockey sticks to wind turbines. If the development of CNT-reinforced aluminum proves to be equally as fast, then it may soon show up in bioefficient components for vehicles and planes. The skyrocketing career of these mighty midgets has only just begun!



www.pa.msu.edu/cmp/csc/nanotube.html

This website provides plenty of information about carbon nanotubes.