Research and waterjet technology lead to advanced materials development

Florida State University's High-Performance Materials Institute is paving the way when it comes to narrowing the gap between research and the practical use of a new, high-performance composite material that could be up to 10 times lighter and 250 times stronger than steel, twice as hard as diamond, and highly conductive to electricity and heat.

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As the gap continues to narrow, this new material could revolutionize the world of manufacturing, from producing more energy-efficient aircraft to providing improved protective equipment.

Buckypaper: made of nanotubes

The High-Performance Materials Institute's research of this extraordinary material, known as buckypaper, has already shown promise in a wide variety of real-world applications. Consider the aerospace industry. Instead of the current metal mesh used in the structure of the composite aircraft to disperse lightning strikes, replacing the metal with buckypaper, which has high current-carrying capacity, would allow lightning's electrical charge to flow around the plane and dissipate without causing damage. Buckypaper could also make aircraft stronger and lighter for increasing payloads and improving fuel efficiency.
Made of nanotubes, one of the most thermally conductive materials known, buckypaper might lend itself to the development of heat sinks, enabling computers and other electronic equipment to disperse heat more efficiently than what is currently possible. And if exposed to an electric charge, buckypaper films could illuminate computer and television screens. When compared to cathode ray tube and liquid crystal display technology, these screens could be lighter, more energy efficient, and feature a more uniform level of brightness.

Furthermore, buckypaper is flame retardant and could one day help prevent fires on aircraft, ships and other structures. Its amazing strength-to-weight ratio might also prove ideal when making protective gear, including helmets and body armour, for the military and police, as well as create improved, more comfortable prosthetics for wounded soldiers.

To the naked eye, buckypaper looks like ordinary carbon paper but under

Fig. 1: The High-Performance Materials Institute works with an extraordinary material known as buckypaper. When sheets of buckypaper are stacked together to become part of a composite structure, it can transform into one of the strongest materials known to man.

a microscope, one can see it is made from tube-shaped carbon molecules 50,000 times thinner than human hair. When sheets of buckypaper are stacked together to become part of a composite structure, it can transform into one of the strongest materials known to man.

State-of-the-art equipment

Situated inside a new $20 million, 4,200 m² building that houses 13 laboratories, the High-Performance Materials Institute brings together highly technical researchers and state-of-the-art equipment to continually explore and realize the astounding potential of NOLES, or nanotubes optimized for lightweight exceptional strength. Researchers go from idea to concept to prototype and beyond, working one-on-one with private businesses and the government with complete confidentiality to meet the specific needs of each partner.

Both researchers and students have access to the facility's equipment that is valued at more than $10 million. They can watch the tiniest particles come alive under a scanning electronic microscope that has 100,000 times more magnification than what is found in a high school laboratory. And what once seemed impossible to cut, researchers and students can easily slice away strong composite materials thanks to a powerful abrasive waterjet machine. In fact, the Institute has been successfully using an OMAX 55100 JetMachining® centre for the past six years to quickly and accurately cut a wide variety of components, some less than 6 mm in size.

Fig. 2: The High-Performance Materials Institute relies on an OMAX® 55100 JetMachining® Center to quickly and accurately cut a wide variety of components, including carbon fiber composites.

Fig. 3: Composite materials generate a lot of dust when dry cut on a CNC machine, which can be harmful if breathed in. Therefore, the High-Performance Materials Institute relies on the OMAX® 55100 JetMachining® Center to create a cleaner, safer working environment for cutting strong composite materials.

A cantilever-style machine

The composite materials the Institute works with are really strong, and they can't think of a material they haven't cut on the OMAX centre. It doesn't matter how strong the material is because the waterjet machine will cut through anything.

The 55100 is the largest cantilever-style machine within OMAX's diverse product portfolio. It is designed to accommodate the cutting of large, complex parts and can handle sheet materials of up to 1.5 x 3 m in dimension. Furthermore, the 55100's user-friendly controls simplify the programming of traditionally complex techniques. In fact, students' components can be machined directly from a CAD drawing or DXF file.

This machine is versatile and intuitive with software that's easy to use. It features OMAX's innovative Intelli-MAX® Software Suite, which runs on the Windows® 7 Ultimate operating system. The software, for which OMAX provides free upgrades for the life of the machine, automates programming and tool setup work, virtually eliminates the need for extensive operator training and offers quick turnaround of short-run projects and large-volume, mass-production projects. Furthermore, the software enables the 55100 to offer higher average cutting speeds and greater precision than competitive designs.

The machine is very useful because it adds to the overall specimen quality, particularly in terms of the cut.

Waterjet machining

The OMAX 55100 is also highly important to the High-Performance Materials Institute because waterjet machining is cleaner and safer than CNC machining. After all, when composite materials are dry cut, dust gets all over the place and can prove harmful if inhaled.

Right now, the Institute is producing buckypaper at only a fraction of its potential strength, in small quantities and at a high price. Nobel Laureate Dr. Richard Smalley first produced buckypaper during the 1990s by filtering a nanotube suspension in order to prepare samples for various tests.