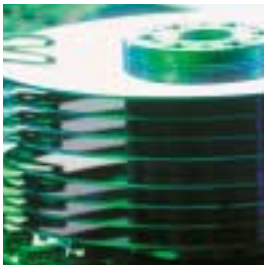


Hyperion Catalysis

THE LEADER IN
NANOTUBE TECHNOLOGY

THE LEADER IN NANOTUBE TECHNOLOGY

Hyperion Catalysis

LET US HELP YOU WITH YOUR NEXT APPLICATION

To support the development and proliferation of new nanotube applications, Hyperion staffs a Plastics Technology Center at the company's Cambridge headquarters. This resource allows the company to provide developmental lots of masterbatches and compounds to respond to customer requests faster and more effectively. Industry experts from the plastics, automotive, and electronics industries are also on staff to assist with application development in core, conductive plastics applications. Furthermore, the company's scientists continue to work on emerging technologies for unique forms of carbon. Let Hyperion help you with your next application.

CONTACT US

Hyperion Catalysis has a sales presence in the U.S., Japan, Pacific Rim, and Europe.

For more information, call customer response at +1.617.354.9678 ext 2344; or send a fax to +1.617.354.9691; or e-mail response@HyperionCatalysis.com.

Our website can be found at www.HyperionCatalysis.com.

SPECIAL BENEFITS

Carbon nanotubes are 10-12 nm in diameter – more than 5,000-times thinner than human hair – and 10-15 microns (µm) long. Due to their unusually high aspect ratio (1:1,000+), these submicroscopic tubes provide a highly effective, electrically conductive network when compounded with non-conductive materials such as plastics, even at low loadings.

Typical usage levels of FIBRIL™ nanotubes range from 1-5% vs. 8-12% for chopped or milled carbon fiber, nickel-coated graphite, or metal fibers, and 8-20% for carbon black. Because of their tiny particle size and lower loading levels, nanotubes have fewer negative effects on the physical, mechanical, and processing properties of the base polymer than other electroconductive additives. Additionally, FIBRIL™ nanotube-filled compounds can provide excellent molded-part quality, meeting the automotive industry's Class-A surface requirements and the electronics industry standards for minimal sloughing.

FIBRIL™ nanotubes are nonreactive and chemically clean. Unlike carbon fiber, they require no sizing agents and unlike carbon black, they contain no sulfur, which can damage delicate microelectronics. Because they are so small and strong, FIBRIL™ nanotubes offer higher regrind stability than other conductive additives, making it easy to melt reprocess runners, sprues, and parts during production, as well as recycle molded components at end-of-life.

EMERGING TECHNOLOGIES – CATALYST SUPPORTS & OTHER PLATFORMS

FIBRIL™ nanotubes are also the basis for a family of catalyst supports. The nanotubes are fused together to form a strong, highly mesoporous, open-cell structure that can outperform activated carbon as a support for precious-metal catalysts. A nanotube-based catalyst support offers faster or more selective reactions. Greater selectivity or speed benefits the fine chemical and pharmaceutical industries.

Other emerging applications for FIBRIL™ nanotubes include flat-panel displays, advanced batteries and fuel cells, and plastic reinforcements.

ABOUT OUR COMMERCIAL PRODUCTS

Hyperion offers the broadest range of polymeric masterbatches in the industry for a wide range of thermoplastic compounds, including:

Amorphous
- Polyetherimide (PEI)
- Polycarbonate (PC)
- Polystyrene (PS)

Semi-Crystalline
- Polyetheretherketone (PEEK)
- Polyphenylene sulfide (PPS)
- Nylon (PA) 12, 6, and 6,6
- Polyesters (PET and PBT)
- Polypropylene (PP)

Fluoropolymers
- Polyvinylindene fluoride (PVDF)
- Ethylene tetrafluoroethylene (ETFE)

All masterbatches are supplied in pellet form, in either drum or half-ton box units. Processors can vary the letdown ratio on the masterbatches to optimize the conductivity level of a molded plastic part to meet its end-use application.

Hyperion Catalysis

The name Hyperion ("hi PEER ee en") comes from Greek mythology. Hyperion was a Titan and the father of Helios (the sun). In astronomy, Hyperion is also the name of one of Saturn's moons.

FIRST IN *Nanotube Technology & Production*

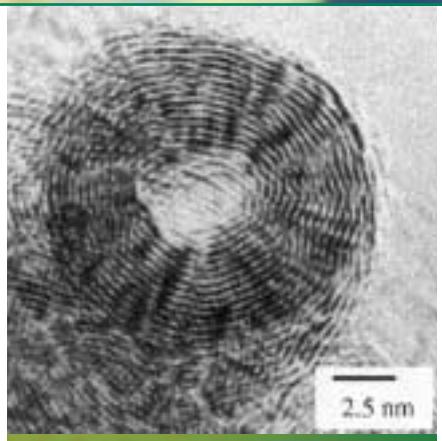
Hyperion Catalysis International was founded in 1982 with a broad charter to develop advanced materials. A year later, company scientists synthesized the world's first multi-walled carbon nanotubes. These high-purity, vapor-grown conductive products are Hyperion's flagship technology and are sold commercially as FIBRIL™ nanotubes.

Hyperion has emerged as the world's leader in the development, production, application, and commercialization of carbon nanotubes. The company is headquartered in Cambridge, Massachusetts.

THE NANOTUBE *Pioneer*

Although research had previously been done on unique forms of elemental carbon (see sidebar), none of that work had yielded a material with much commercial value. All that changed in 1982 when Dr. Howard Tennent, a chemist with an extensive industrial research background, invented a unique catalytic process to grow small, high-purity carbon nanotubes at Hyperion.

Much of the rest of the '80s was spent refining and expanding Dr. Tennent's catalytic manufacturing process and working on application development. In the 1990s, the first commercial applications for FIBRIL™ nanotubes – in the area of electrically conductive plastics – were introduced. Since that time, Hyperion has remained a leader in the development of new polymer masterbatches as well as other nanotube applications. The company also continues to follow its charter to develop novel forms of carbon.



A SHORT NANOTUBE HISTORY

Soon after the invention of the electron microscope, some carbon deposits were discovered to be rich in filamentous forms of carbon. In the 1970s, numerous research groups, working independently, grew significantly larger and highly impure multiwall carbon nanotubes. While of scientific interest, these tubes had low economic value because they had relatively low electrical conductivity and were not made by processes that allowed commercial-scale manufacturing.

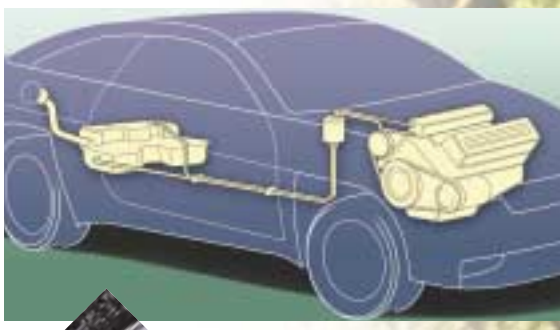
In 1983, Hyperion became the first company to synthesize the small, high-purity, multiwall form of nanotubes. These nanotubes are a very pure form of graphitic carbon, with the planes of the graphitic structure lying parallel to the tube axis. Hyperion continues to develop wide commercial applications for nanotube use.

THE VOLUME NANOTUBE PRODUCER

Not only was Hyperion the first company to create multi-walled nanotubes, but also it was the first company to manufacture nanotubes on a commercial scale. Today, the company is the world's largest and only tonnage nanotube producer. (Most other producers are still restricted to manufacturing in laboratory-scale volumes by their processes.) Hyperion has the longest history of producing and selling nanotubes of any company globally.

THE LEADER IN APPLICATION DEVELOPMENT

Hyperion was the first company to develop commercial applications for nanotubes – in the area of conductive plastics – and is also the leading company in terms of breadth and depth of commercial nanotube applications. No other nanotube supplier has more applications or more types of applications in the field, and no nanotube company or compounder has more real-world application-development experience than Hyperion.



Photomicrograph of dispersed graphite FIBRIL™ nanotubes

CURRENT TECHNOLOGIES

Conductive Plastics

Conductive plastics is the largest commercial application for FIBRIL™ nanotubes. Automotive and electronics are the two major industries that currently make use of thermoplastics filled with FIBRIL™ nanotubes. (See sidebar for explanation of benefits.)

Automotive

In the automotive industry, thermoplastic compounds using FIBRIL™ nanotubes can be electrostatically painted, eliminating primer steps, reducing solvent emissions, limiting overspray, and making it easier to wrap paint around corners and into deep design details. Low loading levels mean nanotubes do not compromise important mechanical properties (e.g. low-temperature ductility), so parts can be used in large exterior body panels as well as mirror housings, door handles, and trim applications.

FIBRIL™ nanotubes are also a key additive in nylon fuel lines, fittings, fuel filter housings, and other fuel-system components where they prevent dangerous static buildup while maintaining the low-temperature ductility of the nylon.

Electronics

In the electronics field, the smooth, highly homogeneous part surface of thermoplastic compounds using FIBRIL™ nanotubes means minimal sloughing (or rub-off) of surface particles. Plastics with high rub-off cause problems, because the particles can be a damaging contaminant in today's ultra-clean, electronic production environment. Furthermore, FIBRIL™ nanotubes are nonreactive and chemically clean, helping protect delicate microelectronics.

Compounds filled with FIBRIL™ nanotubes are currently used to mold silicon-wafer handling tools (e.g. tweezers, wands, and rails for front opening unified pods (FOUPs)), and material transport trays and components for computer hard drives.

FOUP Photo courtesy of Integrated Dynamics Engineering Worldwide.