Nanofibers: A Novel Approach to Filtration

eSpin Technologies, Inc.

7151 Discovery Drive
Chattanooga, TN 37416
Telephone: 423-267-6266
http://www.espintechnologies.com

Environmental Problem

Indoor air contaminants, such as volatile organic compounds (VOCs), microorganisms, allergens, and other pollutants (e.g., tobacco smoke) pose serious health- and productivity-related problems for occupants of indoor spaces. These toxic compounds are complex mixtures of particles, 90% of which are smaller than 1 micrometer (μm) in diameter. These particles have hundreds of chemicals adsorbed onto their surfaces, including many known or suspected mutagens and carcinogens. Gaseous pollutants contain many irritants, toxic chemicals, and nitrogen oxides, which are ozone precursors, and can have negative environmental impacts. The minute size and the abundance of these toxins give them a greater opportunity to enter our bodies via air and water. As a result, the filter industry is looking for new filter media that can create effective barriers for particles smaller than 3 μm and adsorb pollutant gases.

SBIR Technology Solution

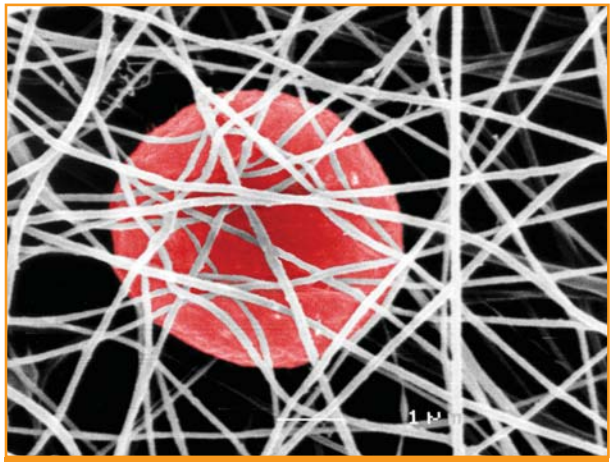
With support from EPA's SBIR Program, eSpin Technologies, Inc., developed and commercialized custom-made nonwoven membranes, whiskers, and 3-dimensional structures using nanofibers. These fibers can be made from a variety of organic, inorganic, or biological polymers. Using a proprietary process, eSpin produces minute fibers that are 100-1,000 times smaller in diameter than fibers produced using conventional textile technologies. eSpin's nanofibers are 20-200 nm in diameter (about 1,000 times smaller than a human hair), have a very high surface area-to-mass ratio, and can be formed into sheet structures with very high porosity and tight pore size.

eSpin's SBIR-supported technology development specifically focuses on removing contaminants present in air by using nanomaterial-based air filtration technology. Applications include advanced media filters that stop particulates smaller than 3 μm and adsorb VOC gaseous pollutants. Enhanced VOC controls will allow benefits for the health and productivity of millions of U.S. workers.

Conventional fiber technology has reached its limits for producing commercially available monofilaments and is likely to produce fibers in the range of 10-50 μm, while nonwoven fibers produced by melt blown technology are in the range of 3-8 μm. Given this situation, filter manufacturers have been compelled to develop and use "exotic" media such as Teflon membranes. Use of Teflon membranes instead of fiber-based filters, however, increases the filter cost substantially, and such filters do not always perform well in field tests. Thus, a major challenge is overcoming the apparent 3 μm particle filtration barrier for a fiber-based filter that has a desirable high-capture efficiency at an affordable cost. eSpin produces nanofibers of unprecedented, unrivalled small diameter with high surface area. Integrating such electrospun polymeric nanofibers with conventional filter media represents a unique opportunity to overcome the current threshold of filterable particle size barrier.

Commercialization Information

eSpin currently supplies nanofiber-based products for development efforts in many different industries, including filtration, performance textiles, energy storage, cosmetics, and others. The company's primary commercialization goal for air filtration applications is to develop and produce an efficient and reliable filtration technology for customers that has a low operating cost and meets or exceeds current



eSpin's nanofibers are 20-200 nm in diameter. This photo compares eSpin's nanofibers to a single blood cell.

Occupational Safety and Health Administration and environmental standards (in anticipation of future air filtration technology mandates). Research in this area resulted in technology that provides a cheaper and better way to clean breathable air by utilizing a highly efficient, cost-effective filter media application.

eSpin currently is working with companies that design and manufacture filtration products and exhaust systems to develop innovative products such as automotive air filters capable of filtering small particles with improved efficiencies of up to 500% compared to existing products. As a platform technology, eSpin's nanofibers have a broad range of market opportunities in traditional and emerging segments of industries such as filtration, aerospace, structural composites, health care, energy storage, cosmetics, and many others.

Company History

Founded in 1999, eSpin Technologies, Inc., is based in Chattanooga, Tennessee, and specializes in custom-engineered nanofiber production. The company has supplied nanofibers for developing unique applications such as clean room products, nanocomposites, filtration products, biomedical devices, and specialty fabrics, among others. eSpin's global partners include Fortune 500 corporations, government and military laboratories, research institutions, and select high-tech companies around the world.

eSpin has received grants and awards from several federal agencies for continued development of nanofiber technology including EPA, National Science Foundation, Department of Energy, Department of Defense (U.S. Air Force), and National Institute of Standards and Technology. eSpin Technologies has been featured in global industry publications such as *Nonwoven World*, *Chemical Engineering News*, and *Nature*.

SBIR Impact

- Indoor air contaminants pose serious health- and productivity-related problems for occupants of indoor spaces, and 90% of these contaminants are smaller than 1 µm in diameter.
- eSpin Technologies developed and commercialized custom-made nonwoven membranes, whiskers, and 3-dimensional structures using nanofibers that are 20-200 nm in diameter.
- Applications of this nanomaterial-based air filtration technology include media filters that stop particles smaller than 3 µm and adsorb VOCs.
- Market opportunities for these nanofibers include filtration, aerospace, structural composites, health care, energy storage, and cosmetics.