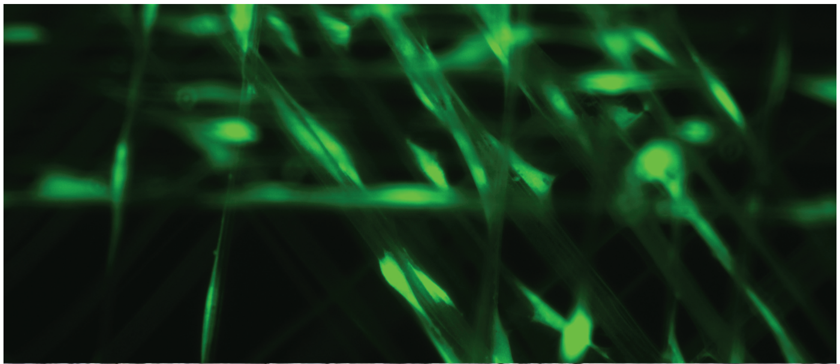
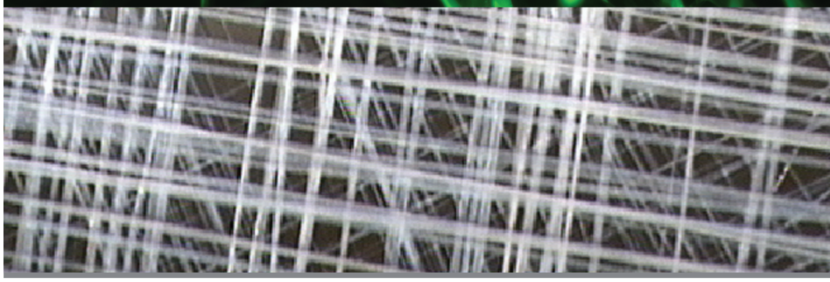




National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Materials and Coatings

Highly Aligned Electrospun Fibers and Mats

Incorporation of an auxiliary electrode for controlled micro- or nano-fiber placement, orientation, and porosity in electrospun mats

NASA's Langley Research Center has created a modified electrospinning apparatus for spinning highly aligned polymer fibers. Fiber placement, orientation, and porosity are difficult to control using conventional electrospinning apparatus. Conventional electrospinning creates randomly oriented fibers that are well suited to nonwoven mats, but not to other applications. Now, NASA Langley has developed the capability to control the alignment and porosity of fibers for mats, which will broaden the range of engineering applications of electrospun materials to include new tissue engineering scaffolds, membrane filters, textiles, and embedded sensors and actuators. The new apparatus provides a simple and inexpensive means of producing fibers and mats of controlled fiber diameter, porosity, and thickness.

BENEFITS

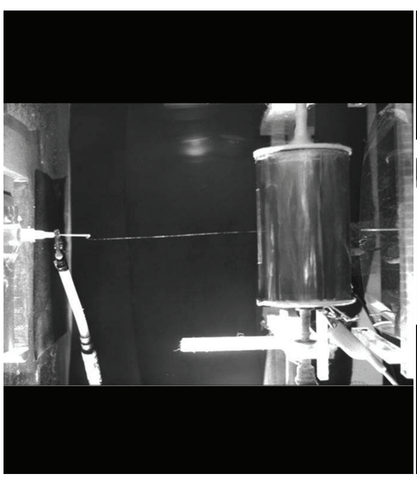
- Consistency and control of:
  --Fiber distribution
  --Porosity
  --Fiber alignment
- Versatility: adaptable to micro and nano fiber sizes
- Repeatable results: amenable to mass production
- Capable of manufacturing single fibers
- Compatible with most polymer solution systems
- Inexpensive processing method

THE TECHNOLOGY

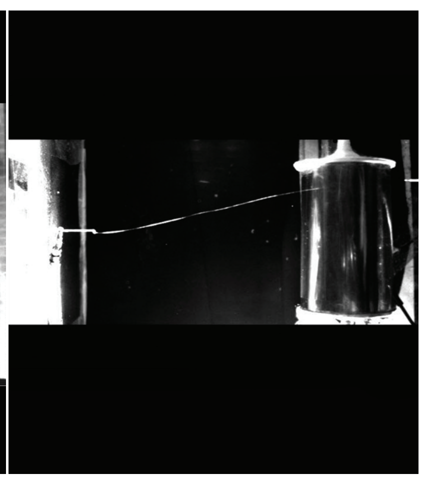
Electrospinning offers a versatile way to produce one-dimensional micro- or nanometer mats; however, electrospun fibers are typically collected in a random orientation, which limits their applications. NASA has developed a new apparatus that uses an auxiliary counter electrode to align fibers for control of the fiber distribution during the spinning process. The electrostatic force imposed by the auxiliary electrode creates a converged electric field, which affords control over the distribution of the fibers on the rotating collector surface.

The process begins when a pump slowly expels polymer solution through the tip of the spinneret at a set flow rate as a positive charge is applied. The auxiliary electrode, which is negatively charged, is positioned opposite the charged spinneret. The disparity in charges creates an electric field that effectively controls the behavior of the polymer jet as it is expelled from the spinneret; it ultimately controls the distribution of the fibers and mats formed from the polymer solution as it lands on the rotating collection mandrel. A broad range of fiber diameters can be manufactured by modifying various parameters of the process and/or polymer solution. Performance data has confirmed the substantial role that the electric field plays in the significant improvement in fiber alignment and control relative to using the rotating collector alone.

Prototypes have been produced, and the repeatability of the process has been confirmed. A patent application has been filed.



Jet stream collecting as a straight fiber on the rotating mandrel



Jet stream with auxiliary electrode positioned offset of the spinneret

APPLICATIONS

The technology has several potential applications:

- Biomedical - tissue engineering scaffolds for cell formation; drug delivery; wound dressing; membranes
- Military - smart textiles and embedded sensors/actuators
- Filter applications - industrial, environmental, automotive
- Instrumentation - sensors for spectroscopy
- Chemical and biological sensors
- Fuel cells and solar cells

PUBLICATIONS

Patent No: 7,993,567

More Information

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