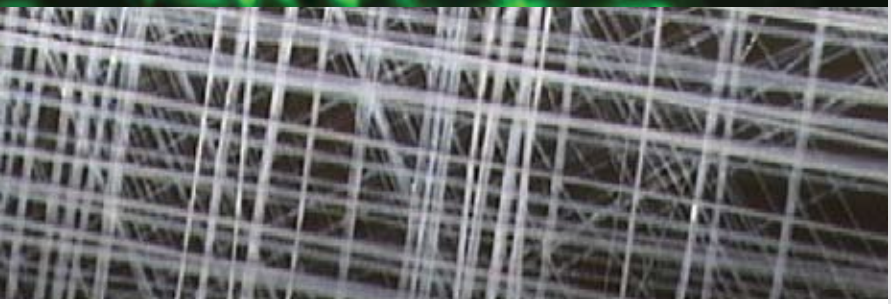
National Aeronautics and Space Administration



NASA Langley's
Highly Aligned Electrospun Fibers and Mats

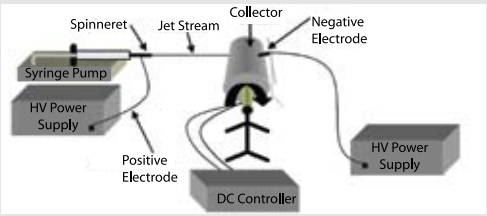
Incorporation of an auxiliary electrode for controlled micro- or nano-fiber placement, orientation, and porosity in electrospun mats

NASA Langley has created a modified electrospinning apparatus for spinning highly aligned polymer fibers and also a companion simulation software program that helps tailor the process for a particular application. Fiber placement is difficult to control in conventional electrospinning, which creates randomly oriented fibers that are well suited to nonwoven mats, but not to other applications. Now, NASA Langley has developed a novel capability that uses an auxiliary electrode that creates an opposing electric field to control the alignment and porosity of fibers for mats. The new apparatus and its companion software will enable the production of single fibers and mats of micro- and nano-fibers with controlled orientation, and allow controlled orientation of the fiber lay-up for multiple layers of fiber to form a thicker mat.

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
- Patent application filed

partnership opportunity



Electrospinning setup incorporating the auxiliary electrode configuration.

Applications

The technology offers wide-ranging market applications, including:

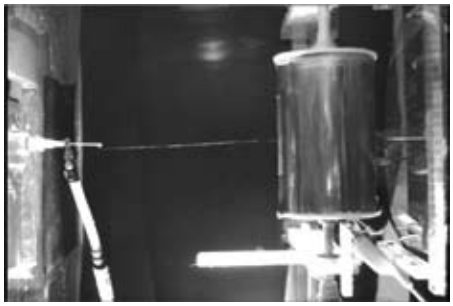
- Biomedical-tissue engineering scaffolds for cell formation, drug delivery, wound dressing, and membranes
- Military-smart textiles and embedded sensors/actuators
- Filter applications – industrial, environmental, and automotive
- Instrumentation – sensors for spectroscopy
- Chemical and biological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

The Technology

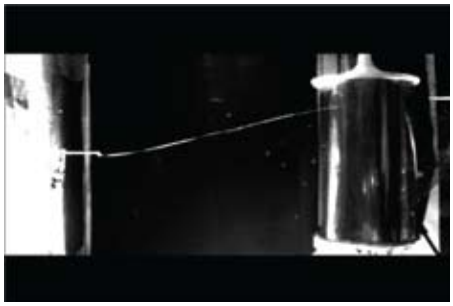
Electrospinning offers a versatile way to produce one-dimensional micro- or nanometer mats; however, electrospun fibers are typically collected in a random orientation, limiting their applications. NASA's new apparatus aligns fibers for control of the fiber distribution during the spinning process through the use of an auxiliary counter electrode. The electrostatic force imposed by the auxiliary electrode provides 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 polymer jet behavior as it is expelled from the spinneret and ultimately 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 made by modifying various parameters of the process and/or polymer solution. The companion simulation software provides the optimal spin parameters, such as electrical field distribution and fiber trajectory, for a particular fiber application. 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.



Jet stream collecting as a straight fiber on the rotating mandrel



Jet stream with auxiliary electrode positioned offset of the spinneret

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

The Technology Gateway

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