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Electrospinning ultra thin polymer fibers

Spinning the finest fibers

Empa scientists have succeeded in constructing a spinning apparatus which is capable of producing polymer fibers with diameters in the nanometer range. The fibers and the machine that creates them will be on display and working at the NanoPubli stand at the Olma Fair in St. Gall from 13th to 15th September.

Carbon nanotubes are the words on everybody's lips these days. It doesn't always have to be carbon, though. Polymer structures can also be created with nanometer dimensions – nanofibers and nanotubes. Such nanostructures are of immense interest for a large number of practical applications because of their outstanding properties. For example, nanostructures have a very large surface to volume ratio, which lends them unusual mechanical, electronic and magnetic characteristics. Examples of applications for which nanostructures are ideal are special filters for gases and fluids, and substrates for encouraging the growth of human tissue such as skin or bone.

Continuous polymer fibers with diameters down to a few nanometers can be manufactured using electrospinning methods, but the product is usually in a disordered form. Empa researchers and technicians have therefore constructed a new spinning apparatus to improve this situation.

Accelerated, spun and stretched

In the elecrospinning process, a high voltage is maintained between the spin nozzle and a counter electrode. The material to be spun, in the form of a solution, is forced under pressure through the nozzle, which is 400 to 700 microns in diameter. If the electric field is strong enough to overcome the surface tension of the emerging liquid, it is pulled into a fine jet that is accelerated towards the counter electrode, spun in the air and thereby drawn into long fibers. The solvent evaporates and the fibers collect on the counter electrode with a velocity of up to 100 meters per second.

Although it sounds simple in principle, in reality the spinning process is quite complicated. Numerous parameters influence the process, including the concentration of the solution, the dielectric constant of

the solvent, the strength and shape of the electric field and environmental conditions such as the relative humidity of the air. It demands experience and skill from the experimenter to adjust the process parameters so that fibers form and not just droplets, and on top of this for every new material a new set of optimal parameters must be established.

Filter systems for medicinal applications

To date the Empa researchers have been able to successfully spin a number of polymers and other materials including polyamide, polyethylene oxide, polyvinyl pyrrolidone and wool protein in combination with polymers. The latter material can be used as a biocompatible substrate on which to grow cells.

The current scientific task is to establish the optimal layout and operation of the apparatus in order to be able to spin fibers with complete control. A further aim is the manufacture of filters for medicinal applications, and for this purpose filter materials are given an additional coating of nano fibers. The electrospinning process is particularly suitable for this application since it takes place at room temperature. Heat -sensitive active agents can thus be directly mixed into the fibers that are then coated onto the filter materials.

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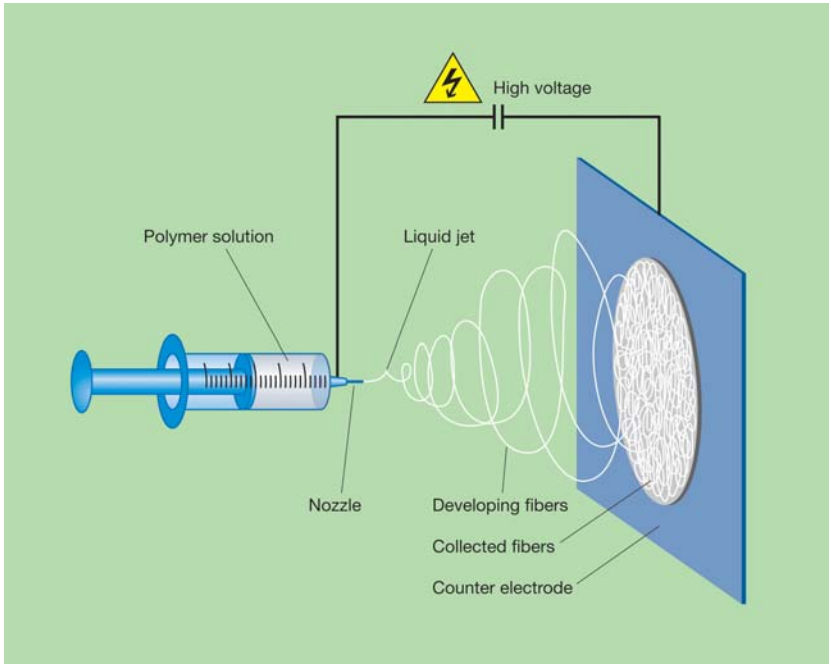
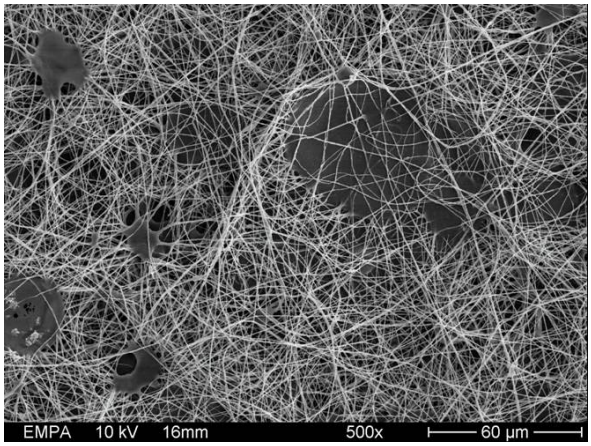
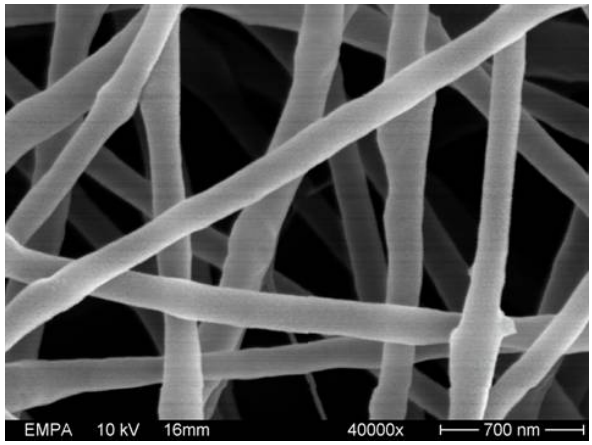


Electrospinning: An electric field accelerates the jet of polymer solution, which follows a spiral trajectory and is elongated enormously. The nanometer thin fibers collect on the counter electrode with a velocity of up to 100 meters per second.





The polymer fibers produced by the electrospinning technique are just a few nanometers in diameter. They are particularly suitable for manufacturing special filters, and substrates for the growth of human tissue

Images are available in digital form from remigius.nideroest@empa.ch

NanoPubli – a special event within NanoEurope in St. Gall

Empa and NanoEurope invite the public to take part in a dialog with nanoscience and nano-industry. You will be presented with comprehensive factual information about the opportunities offered by nanotechnology as well as the risks involved. Empa staff and partners from the universities and from industry will display the latest results from the field that boasts the smallest material structures, and introduce you to products that have already taken their place in our everyday lives. Grasp this opportunity and experience for yourself at first hand the fascination of «Nano made in Switzerland»

Location: Olma Fair, St. Gall

Dates: 13th – 15 th September 2005

Entry free

Further information at: www.nanoeurope.com