New nanotech fibre technique to light up European industry

February 26 2016

A new cost-effective method of fabricating high quality light-emitting fibres could benefit sectors ranging from sensors to wearable smart devices.

EU-funded researchers have developed a new method for manufacturing fibres made from nanostructured organic materials. The breakthrough could lead to the cost-effective fabrication of light-emitting fibres at the nanoscale that can be used in sensors and bio-sensors, for energy harvesting (i.e. solar panels) and even in 'smart' clothing that can react to the environment.

Other potential applications include smart wearable devices, point-of-care diagnostics for medical professionals and home automation applications for lighting and sound systems.

Structures at the nanoscale are usually between 1 and 100 nanometres – a nanometre is a billionth of a metre – and can possess properties that offer manufacturers amazing strength, flexibility and / or electrical conductivity. However, while significant advances in nanotechnology have been achieved in recent years, the nanofabrication of light-emitting fibres has proved difficult to optimise.

One reason for this is that there are so many variables in the manufacturing process that must be controlled, which pushes up costs and reduces production efficiencies. For example, the presence of oxygen and moisture in the processing environment can severely affect the optical properties of certain compounds, and thus impact the efficacy of the nanostructures built from them.

New manufacturing technique

In order to address this, the five-year NANO-JETS project, which began in 2013, has pioneered a new manufacturing technique called electrostatic spinning, or 'electrospinning'. In this technique, electrified fields are applied to produce polymer filaments, which can then be embedded in various device platforms.

The first step of the process involves placing a polymer solution into a syringe, which is then pushed to the tip of a metallic needle by external pumping. Pumping is usually applied by mechanical pistons, which generates a flow of the solution in the syringe. A high concentration of polymer solvent is needed in order to achieve a sufficient amount of entanglements between macromolecules in the solution.

An electric volt is then applied between the tip and a collector placed in front of it. The applied voltage is gradually increased, elongating the droplet to form an apex and finally a jet. The velocity of the jet can reach values of a few metres per second. The solvent quickly evaporates from the jet, and solid nanofibers are finally deposited on the collector. A key advantage to end users is the fact that these collected fibres are generally flexible and can conform to surfaces of all shapes.

In their initial tests, the project team used a controlled nitrogen atmosphere with oxygen content below two parts per million. This enhanced the optical properties of the collected fibres. Other discoveries included the fact that low levels of ambient humidity lead to reduced surface roughness of individual light-emitting fibres. All this will contribute towards the development of more efficient manufacturing practices.

Next steps

The NANO-JETS project is due for final completion in February 2018. The team will now investigate ways of extending the variety of processed materials in order to achieve new classes of light-emitting fibres, and investigate the light-transport properties of samples made of multiple filaments.

More information: NANO-JETS project website: www.nanojets.eu/

Provided by CORDIS

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https://phys.org/news/2016-02-nanotech-fibre-technique-european-industry.html