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New 3D printing technique for environmental nanodevices

A nanoscale 3D printing technique could be useful for nanomanufacturing processes with environmental applications. The authors of a new study have found a way to control their printing process by incorporating a simple pattern into the printing surface. They say their technique could reduce costs for nanoscale printing.

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Nanoscale manufacturing methods are already being used in environmental applications, such as water purification, and nanoengineers have tested approaches to cleaning up oil spills based on nanomachines[1]. 3D printing may be one way to speed up the manufacture of nanoscale objects and devices needed for these applications. The technology is becoming increasingly affordable and produces minimal waste, but it is more difficult when the objects being printed are very small.

One possible method is called 'dip pen nanolithography', which uses an atomic force microscope (AFM) tip coated in 'ink' molecules. An alternative is 'electrojetting', in which nanofibres are squirted from a liquid through a nozzle under an electric field. However, with both techniques the shape and arrangement of what is produced cannot be easily controlled.

The authors propose a new method for nanoscale 3D printing that uses nanofibres made by electrospinning. In electrospinning, a voltage is applied to the substance — in solution — being spun, giving it a charge. The electrified substance is spun onto a screen or plate with the opposite charge, where the liquid solvent evaporates immediately, leaving just the fibre.

Electrospun nanofibres have been considered for environmental applications, such as membranes to filter pollutants or toxins from water, as well as for biomedical applications, such as building artificial tissue scaffolds[2].

Although electrospinning is an old technique that is already familiar to nanotechnologists, it has not been possible to control the fibres that are produced in this way. In their study, the researchers used a syringe as a spinner and spun their charged printing solution of poly(ethylene oxide) (PEO) onto a very thin strip of oppositely charged platinum on a glass printing surface.

The platinum functioned as a pattern and allowed them to control how the fibres are deposited. The jet was attracted to the platinum, and formed a 180-nanometre wide (less than a thousandth of a millimetre) thread along its length.

The researchers were able to move the spinner back and forth, building up a 220-micrometre long 'wall' of thread, stacked 25 fibres deep, in under two tenths of a second. As they added each new layer of fibre, it took on the same charge as the platinum, helping to attract the next layer from the oppositely charged oncoming nanofibre. They went on to stack up 300 fibres and found that longer walls were more stable.

According to the researchers, their technique has the potential to reduce the cost of nanomanufacturing processes because it only requires a relatively basic set-up compared with techniques previously used to build nanowalls. In addition, more complex metal patterns could be created on printing surfaces, making it possible to build more complicated structures using this technique.

1.Guix *et al*. (2012) Superhydrophobic Alkanethiol-Coated Microsubmarines for Effective Removal of Oil. ACS Nano 6 (5), 4445-4451.

2.Ramakrishna *et al* (2006) Electrospun nanofibers: solving global issues. Materials Today 9(3):40-50.