Engineers make major breakthrough in developing silk 'micro-rockets' that can be used safely in biological environments

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Sheffield engineers make major breakthrough in developing silk 'micro-rockets' that can be used safely in biological environments.

By using an innovative 3D inkjet printing method, researchers from Chemical and Biological Engineering at the University of Sheffield have taken the biggest step yet in producing microscopic silk swimming devices that are biodegradable and harmless to a biological system.

This means that these devices have the potential to be used in the human body in the future in applications such as drug delivery and locating cancer cells.

This new technique allows the researchers to use safer, non-toxic materials, meaning the micro-rockets will not cause harm or injure any living tissue or biological environment. This is a significant development as previous devices have been expensive to produce, complicated to manufacture and made from polystyrene beads, carbon nanotubes or metals which have to be covered in a catalyst layer (such as platinum) to be able to swim successfully, these devices are usually less friendly to the biological environment they are placed in.

The rockets are just 300 microns in length and 100 microns in diameter, the thickness of a single human hair, and create their own thrust, allowing them to 'swim' through any bio fluid containing the fuel.

This is the first time these micro-rockets have been produced using a new reactive inkjet printing method, using a solution of dissolved silk mixed with an enzyme. This solution is then placed into a 3D inkjet printer, which, similar to normal inkjet printing, builds up layers of ink to create a column of the rocket.

By printing methanol on top of the printed solution it triggers a reaction which forms rigid rocket shape which traps the enzyme within a silk lattice structure. This enzyme acts as a catalyst, reacting with fuel molecules to produce bubbles that propel the rocket forward.

Using an enzyme as a catalyst and silk to form the rocket, produces a much safer device that is biodegradable, cheaper and simpler to makeway, removing a major barrier to micro-rockets becoming a reality outside of the lab.

Dr Xiubo Zhao, from The Department of Chemical and Biological Engineering at Sheffield states: "By using a natural enzyme like catalase and silk which are fully biodegradable, our devices are far more biocompatible than earlier swimming devices."

"The inkjet printing technique also allows us to digitally define the shape of a rocket before it's produced. This makes it a lot easier to optimise the shape in order to control the way the device swims."

The research was funded by grants from the Engineering and Physical Sciences Research Council (EPSRC). The paper 'Reactive inkjet printing of biocompatible enzyme powered silk micro-rockets' was published in *Small* today.

More information: David A. Gregory et al, Reactive Inkjet Printing of Biocompatible Enzyme Powered Silk Micro-Rockets, *Small* (2016). DOI: 10.1002/smll.201600921

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