'Harvesting' microparticles from a liquid jet

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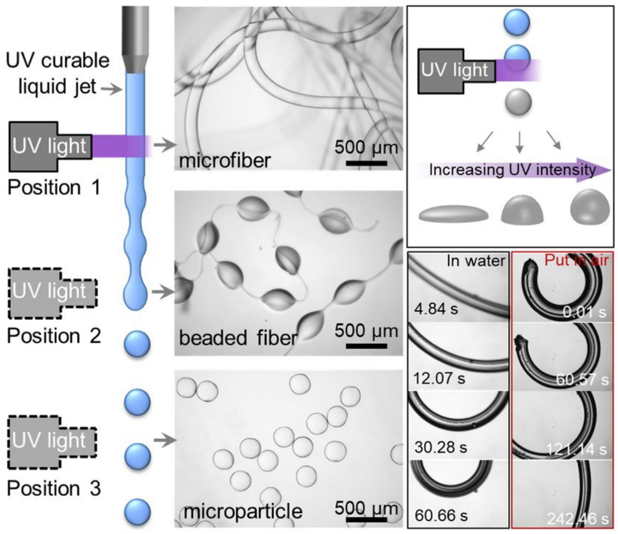


Depending on the location of the UV irradiation of the liquid jet, fibers, beaded fibers or microparticles are formed. Credit: University of Twente

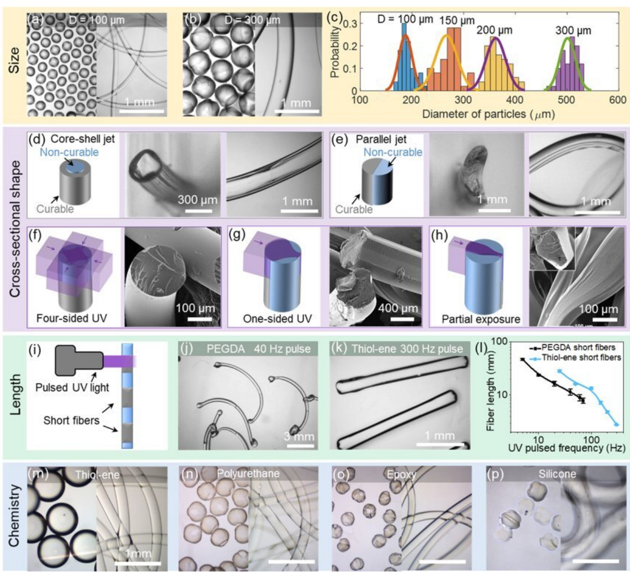
Microspheres, microlenses and microfibers can now be produced by irradiating a fluid jet with ultraviolet light. The result is that locally, a polymer of a desired shape is formed. This process, called in-air photopolymerization, enables manufacturing of a wide range of bio-inspired microparticles. The technique is faster than existing techniques and delivers particles of very constant quality. Researchers at the University of Twente present their work in *Advanced Materials* of 4 December.

Bio-inspired materials are in high demand, including microparticles that stimulate blood circulation or improve vaccine delivery, patches with microneedles that painlessly inject microfibers attaching themselves to your body, and microlenses mimicking insect eyes. These require well-defined building blocks that can be assembled in vast quantities. Still, existing manufacturing processes are labor intensive, too slow, difficult to tailor or result in excess size deviation. Creating the particles can be done using lab-on-a-chip technology, which is accurate but slow, or using chemical etching techniques requiring several processing steps. In their study, the researchers show that it is possible to produce the desired particles from an ongoing liquid stream at up to 4000 particles per second.

UV irradiation 'on the flow'

At first sight, it looks like inkjet printing: A liquid jet comes out of a nozzle and the continuous flow breaks up in droplets. In this case, however, the researchers irradiate the fluid with ultraviolet light. At the site of irradiation, the liquid forms a polymer and solidifies.

Jieke Jiang, first author of the paper, says, "What material we create is determined by the location. If we illuminate the liquid jet of polyethylene glycol diacrylate while it is still continuous, we can create fibers. If the jet breaks up in droplets, we can make microspheres. Using pulsed light, we can create fibers of a length that is very well determined. Apart from that, we are able to play with the chemistry. By adding polyurethane, for example, we can make stronger fibers. We are able to control all of these properties in a very precise way."



A wide variety of shapes and sizes is possible under highly controlled circumstances. Credit: University of Twente

Janus fibers

It is even possible to create hollow fibers, so-called Janus fibers: Like the Janus head, with its two faces, the process combines two materials. This is made possible by illuminating not one but two liquid jets at the same location. Using two materials, active fibers are created that can respond to stimuli. The technique is capable of creating well-defined microlenses that could enhance the energy efficiency of solar cells or improve the yield of LED displays.

Earlier on, the UT researchers presented a technique for printing gels by letting two liquid jets join. Team leader Claas Willem Visser says, "We called this in-air microfluidics, and the polymerization technique we have now developed is a new version of it. The technology led to the IamFluidics company, aiming at sustainable microparticles for pharmaceutics, life sciences and cosmetics, avoiding the use of plastics. In the longer term, we expect it will be possible to use particles for printing living tissue, for tissue engineering, for example."

More information: Jieke Jiang et al. Continuous High?Throughput Fabrication of Architected Micromaterials via In?Air Photopolymerization, *Advanced Materials* (2020). DOI: 10.1002/adma.202006336