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Molecular motors push liquid uphill

Duncan Graham-Rowe

Droplets of liquid have been moved uphill by molecular motors designed to manipulate Brownian motion.

While other researchers have found ways to make drops of liquids move before, what is new here, says David Leigh at the University of Edinburgh, is the use of molecular motors to achieve it: “This is the first time you can use molecular-level motion to move a macroscopic object. OK, so it’s only a tiny droplet – but it’s a start.”

“You could pump liquids around a silicon chip,” says Leigh. With very small quantities of liquid, and with traditional pumps, this can be difficult as the liquid becomes very viscose at that scale. “It would be like trying to pump treacle.”

The so-called “nano-shuttles” could also create a range of different types of smart surfaces, such as adhesive surfaces that can be switched on and off, or surfaces that can be switched from one colour to another.

Molecular motors are employed in living organisms in a wide range of tasks – from making muscles move to translating light signals into nerve impulses in the retina. Leigh thinks there is vast untapped potential in molecular motors: “Nature uses them for almost everything and we use them for almost nothing."

Instant non-stick

Leigh and his colleagues at the University of Bologna, Italy, and the Materials Science Centre of the University of Groningen in the Netherlands, created light-sensitive nano-shuttles. These are long hydrocarbon-based molecules each with a ring of organic molecules strung – but not chemically bonded – around them.

Brownian motion – the random motion of tiny particles – would normally cause these rings to move backwards and forwards along the hydrocarbon molecules. But they also added hydrogen bonding groups at each end, one group being light sensitive and the other group being Teflon based.

Under normal lighting the ring sticks to the light-sensitive bonding station leaving the Teflon end exposed. But exposure to ultraviolet light causes a reaction that frees the ring, allowing it to move to the other end where it gets stuck again, this time to the Teflon bonding station.

The effect means that coating a gold surface with a nano-shuttle layer just one molecule thick means the surface can be switched from being Teflon-covered or Teflon-free by switching the light on and off.

Then, by controlling where the UV light hits the surface, it is possible to manipulate an oily drop of liquid, says Leigh, and even push it up an incline of 12°. View a movie of the drop moving uphill, here (avi format). Leigh thinks it is unlikely they could get much steeper than this.

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