Photo-Chemopropulsion
Light-Stimulated Movement of Microdroplets
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Introduction
The ability to selectively transport chemical species in a controlled fashion, typically against chemical and electrochemical gradients, has been the cornerstone of the development of complex natural systems. While transport over short distances (e.g., intracellular) is typically achieved by cargo-carrying motor proteins acting like conveyor belts in a factory, active transport through natural fluids requires a biological “motor” to drive a carrier through the fluid resembling a miniature submarine. Emulating this latter approach in synthetic fluidic systems, we developed an inanimate/chemical system in which an organic droplet is self-propelled in response to a photo-stimulus. The centimetre-scale directional movement of the organic droplet on the aqueous solution is powered by the combination of photo-induced pH change and surface tension effects.

Photo-controlled pH
Dissolution of SP-So3H in water leads to dissociation of the sulfonic acid and ring opening of the SP form an equilibrium mixture of yellow MCH+SO3- (predominant) and red MC-SO3- (pH5). Upon white light irradiation, the equilibrium shifts as the open forms of the molecule (MCH+SO3- and MC-SO3-) are predominantly converted to SP-So3- resulting in an increase in H+ conc. (pH3.4).

Photo-chemopropulsion
The principle of photo-chemopropulsion offers new possibilities to employ light as an external stimulus for controlling droplet motion at the liquid-air interface. This new concept is generic and can be applied to various organic/aqueous systems, making photo-manipulation of microliter-size droplets relatively easy to implement. Here, depending on the intensity of the light source, movement of droplets with speeds in the range of 100 to 4000 µm s−1 can be achieved.

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