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Manipulation of water droplets by optical patterns imprinted on engineered LiNbO3 surfaces

Controlled actuation of liquid droplets on a surface has important implications in many industrial applications, such as heat transfer, water harvesting, energy generation, and even in clinical diagnostics. In recent years, various strategies have been used to control the motion of droplets, either in an active or passive manner. In this work, an optofluidic platform that performs the basic droplet handling operations required in a common microfluidic device is presented. In detail, it is based on z-cut, iron-doped **lithium niobate crystals** (Fe:LiNbO3) that, upon appropriate **laser illumination**, generate surface charges of opposite sign at the two main faces due to the photovoltaic effect. This provides an evanescent electric field extended outside the active optical material. The face of the crystal in contact with the droplets is coated with a lubricant-infused layer, which guarantees hydrophobicity and, more importantly, a very slippery and robust surface for prolonged use. In this way, **sessile water droplets** having volumes of up to a few microliters, corresponding to millimeters in size, can be easily actuated, guided, and merged by projecting on the crystal suitable static or dynamic light patterns, which act as virtual electrodes. The design of light patterns is provided by a spatial light modulator (SLM) capable of producing circular spots or linear stripes. In particular, the light intensity used for this purpose is of at least one order of magnitude lower than that reported in previous studies. The actuated droplets can cover distances of centimeters within a timescale of a few seconds. Furthermore, the resulting platform is highly flexible and reconfigurable after proper discharge and does not require the addition of moving parts.

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