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Droplet motion directed by reversible stiffness gradient on soft switchable surfaces

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Liquid droplet manipulation directed by stiffness gradient has been of great interest because of its numerous advantages in applications such as microfluidic systems (1), liquid collection (2), and tissue engineering (3–5). Patterning a stiffness gradient on the surface allows for moving of droplets towards the softer regions or create a well-known durotaxis effect and make them migrate to stiffer regions in a spatially controlled manner. In most systems, the stiffness gradient is patterned permanently and the effect is static so that the droplets move only in certain planned directions. Surfaces with switchable stiffness properties are of high interest to obtain an on-demand and reversible droplet manipulation. In this project, the lecithin-based photorheological fluids (6) based on spiropyran were modified to be employed as a photoswitchable soft surface. In these materials, a stiffness gradient can be created by light at arbitrary regions. Upon UV exposure, the viscosity and stiffness of the surface decrease more than 10- and 3-fold, respectively, which was confirmed by steady-state and dynamic rheological measurements. The properties alteration was due to the UV-induced structural changes of the material because of the photoswitching of spiropyran to merocyanine form. High resolution (7) and reversible stiffness gradient formation on this soft surface using a UV light provided us the opportunity to move the droplet on top of the surface towards softer areas without any stiffness patterning needed in advance. In the future, the concept will be used to manipulate droplets to coalescence and be taken from all over the surface.

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Sitzung Einordnung: Short talks