„Nanostructures, microswimmers and cells in motion – physical fields at low Reynolds number“

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Microorganisms can move in complex media, respond to the environment and self-organize. The field of nano- and microrobotics takes inspiration from nature and strives to achieve these functions in synthetic systems. However, building synthetic motors and machines ‘bottom up’ such that they can mimic biological matter and function autonomously or such that they can be controlled externally, is challenging. Symmetry-breaking appears to be a pre-requisite for achieving many interesting functions including locomotion, but is difficult to realize with most colloidal and molecular systems. I will describe a physical vapor deposition process that permits us to obtain large numbers of designer micro- and nanostructures with defined shape and material composition. These enable a number of applications, including the realization of nanopropellers that take inspiration from bacteria and that can be used to penetrate soft biological tissues. How one may achieve and control propulsion with magnetic, electric and chemical fields is discussed, as well as aspects of biocompatibility and potential applications in the field of targeted delivery. At slightly larger scales, it is of interest to move and position cells, which is a pre-requisite for efficient implementation of tissue engineering. Moving cells one-by-one is possible in 3D printing, but as will be shown, it is also possible to move cells with a newly observed acoustic effect, the acoustic hologram – that promises ‘one shot’ assembly of matter in 3D.