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OSA travelling lecture

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Optonanofluidics: bio-inspired soft nanofluidic networks created and controlled by light

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Liquid transport in flexible nanoconduits is an important process in biological systems, such as organelles and cells. Therefore, artificial soft nanochannel networks are highly desired to mimic their biological counterparts and to investigate the physics and chemistry of these structures. Nevertheless, the creation of such networks can be a relatively difficult task. A well-known fabrication protocol is based on the micro-manipulation, electroporation and micro-injection of polydisperse giant unilamellar vesicles (GUVs), leading to the creation of lipid nanotubes and daughter vesicles. Although the resulting networks are robust and versatile, this fabrication procedure is quite lengthy (>1hr) and the geometry features of the resulting networks, such as nanotube length and reservoir volume, are poorly controlled.

In this lecture, I will present new approaches for the rapid generation of nanofluidic networks based on the optical manipulation of soft structures and particles at liquid interfaces, including i) surfactant-coated ultralow tension droplets and ii) adhesive GUVs. These contactless approaches offer several advantages, including easy implementation, fast (few mins) fabrication of arbitrary complex 2D/3D networks, fine control over network geometry parameters and ability to connect chemically distinct reservoirs (from fL to nL in volume) across distances from 1 μm to 100s of μm. Novel experimental methods

for the characterisation of the physical properties of these soft structures will be discussed.

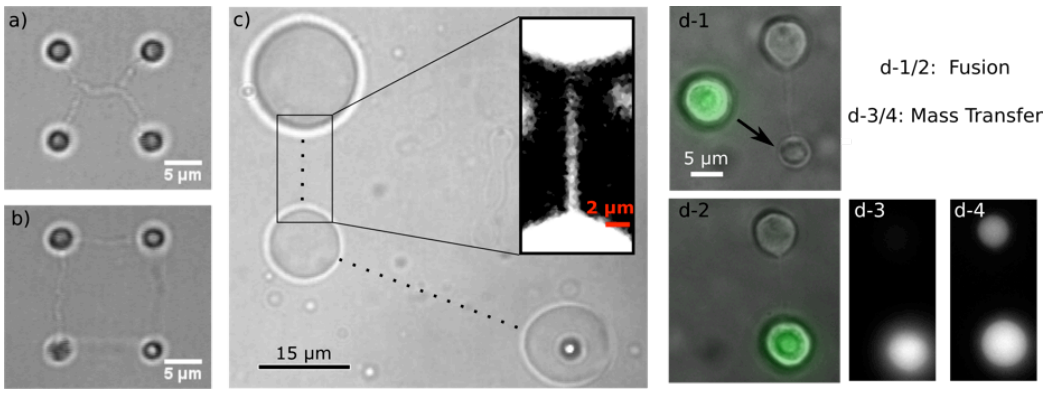

Figure 1: (a-b) Optically trapped drops connected by nanochannels. (c) Surface-immobilised drops connected by nanochannels (dotted lines). (d) Mass transport across a nanochannel