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The assembly of 2D and 3D droplet interface bilayers from cell-sized droplets using optical tweezers

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Droplet interface bilayer (DIB) networks are becoming increasingly considered as powerful minimal-tissue constructs, however a bottleneck preventing the advancement of this technology is the difficulty of positioning cell-sized droplets into customizable 3D architectures. We address this problem by showing the use of optical tweezers to precisely assemble individual microdroplets $\leq 20 \mu\text{m}$ in diameter into complex user-defined 2D and 3D DIB networks. We achieve this by adding sucrose to the aqueous phase to reverse the refractive index contrast of the water in oil microdroplets. This allows us to directly trap the microdroplets in 3D as opposed to exploiting fluid motion generated by the thermocapillary effect or the Marangoni convection effect as reported previously. DIB connectivity between the optically manipulated droplets was confirmed by demonstrating the interdroplet exchange of calcium ions through alpha hemolysin (αHL) nanopores inserted into the membrane. To showcase our ability to method to assemble single and multilayered DIB networks, we constructed both linear and branched symmetric/asymmetric 2D networks together with a 3D droplet tower composed of 11 cell-sized droplets. To our knowledge, the DIB networks assembled using our technique is among the smallest and most complicated reported to date. We envisage that this technology will pave the way for the development of a new generation of minimal-tissues, smart drug delivery systems and bio-electronic circuits assembled from modular droplet components.

Biography

Mark S Friddin has completed his PhD from the University of Southampton. He has joined the Ces group at Imperial College London as a Postdoctoral Research Associate working on the CAPITALS program in January 2015. His research interests focus on the microfluidic assembly of model membranes, the characterization of ion channels using electrophysiology and the development of smart synthetic microsystems for drug discovery.

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