Light: the World's most unlikely Construction Material

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This talk will describe two ways in which optical forces can be used to control the organisation and shape of objects on micron and sub-micron length-scales.

(i) The surface tension of oil droplets is normally many orders of magnitude larger than the force constant of optical tweezers with the result that small emulsion droplets are not measurably deformed by focussed light beams. Close to microemulsion phase boundaries, the interfacial tension of oil-in-water emulsions drops to ultralow values. Optical tweezers can then be used to deform micron-sized oil droplets into predetermined shapes.[1] In principle, 'optical sculpting' provides a novel route to fabricating micron-sized polymer particles of controlled shape.

When a single oil drop is divided into two with a pair of optical tweezers, the daughter drop remains connected to the parent drop by an invisible thread of oil of nanometric diameter. Optical pressure can be used to drive flow between droplets connected by such a nanothread. Strategies can be developed for creating 3-way junctions between nanothreads and for making closed loops of droplets connected by threads.[2]

(ii) The technique of optical trapping, in which scattering of light by single particle leads to a force on that particle, is well-known. Multiple scattering of laser light can also give rise to a force between particles, a phenomenon known as optical binding. Optical binding can result in spontaneous creation of ordered particle arrays, known as 'optical matter'. The symmetry of arrays of sub-micron polystyrene beads in an evanescent field at the silica-water interface depends on particle size and the polarisation of the light. Interesting dynamical effects, with analogies to atomic crystals, are observed.[3, 4]

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3. "Array Formation in Evanescent Waves" Mellor, C. D.; Bain, C. D. *ChemPhysChem* **2006**, *7*, 329.
4. "Emergent Properties in Optically Bound Matter" Taylor, J. M.; Wong, L. Y.; Bain, C. D.; Love, G. D. *Optics Express*, **2008**, *16*, 6921