

OPTICAL TRAPPING

Microassembly

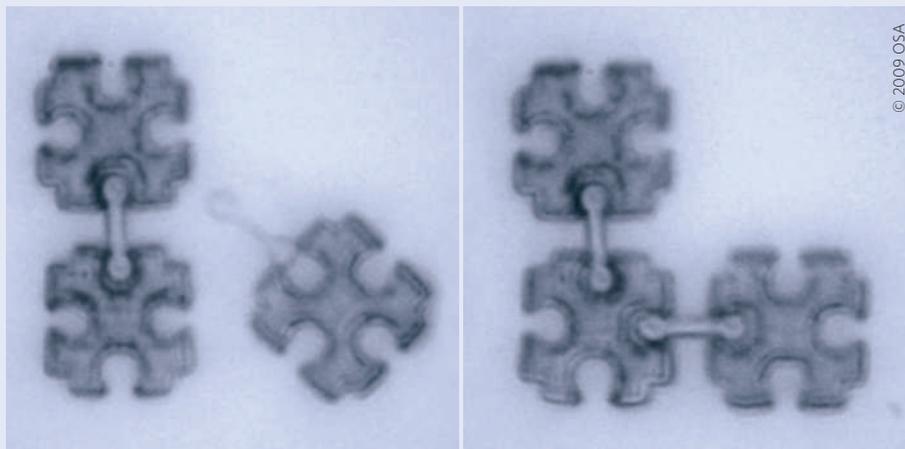
Using their expertise in optical tweezers research and two-photon polymerization (2PP), researchers from Denmark and Hungary have now demonstrated an optical assembly system that can build reconfigurable microenvironments for cells (*Opt. Express* **17**, 6578–6583; 2009).

Their system allows miniature three-dimensional polymer scaffolding of an arbitrary shape to be easily constructed. The work will help investigations into the role that the local environment plays in influencing biological behaviours, such as cell growth and function.

Jesper Glückstad and colleagues use multiple counter-propagating laser beams to trap and move microstructures made by 2PP into user-defined configurations or reconfigurable scaffolds in real time.

As their first proof of principle, the team fabricated and then manipulated microscale dumbbells (two spheres, 3.8 μm in diameter, connected by a cylindrical rod with a length and diameter of 5.4 μm and 2.2 μm , respectively) and square blocks (8 μm thick and 17.5 μm side length) featuring four circular holes with a diameter of 5 μm . The microcomponents were made from an epoxy-based resin by 2PP and then organized and connected together with the aid of multiple optical traps.

The traps were formed by passing a 1,064-nm continuous-wave fibre laser



beam through a spatial light modulator to produce two matched sets of counter-propagating beam traps which were incident on the sample chamber from opposing directions. Quadruplets of counter-propagating traps were also generated to move the micro-blocks. The traps can be simultaneously configured by a computer graphical user interface, offering real-time, three-dimensional control by adjusting the power of the light beams.

The researchers showed that the multiple-trapping scheme can be used to translate and rotate the micro-blocks and dumbbells and assemble them into composite structures. What's more, they are confident that the scheme could be applied

to structures made from other materials and in other shapes.

"Building blocks made from different materials and with nanometric features can be fabricated and reconfigured to trigger cellular reactions and facilitate selective chemical functionalization," Glückstad says. He also points out that by adding in advanced spectroscopic techniques, their optical assembly platform could be used for biochemical probing. "With a generalized microassembly platform, we see no problem in assembling different microdevices and micromachines in one system," says Glückstad.

RACHEL WON

QUANTUM PHOTONICS

Quantum optics on a chip

Researchers have demonstrated a reconfigurable photonic circuit on a chip that can create a four-photon entangled state. The scalability and compactness of the device opens the door towards practical quantum computation.

Dominic W. Berry and Howard M. Wiseman

In the latest work from the quantum photonics group at the University of Bristol, described on page 346 of this issue, Jonathan Matthews and colleagues report the construction of a reconfigurable quantum optical circuit on a chip and the control of entangled states with up to four photons¹. The heart of their device is a simple heating element that changes the phase in one arm of an interferometer.

This circuit serves as a building block for potentially constructing arbitrarily large quantum optical circuits, an important step in the quest for quantum computation².

Quantum computation is part of the broader field of quantum information, which aims to develop a range of new technologies based on manipulating quantum systems, usually those with two levels, known as quantum bits, or qubits.

Quantum key distribution, also widely known as quantum cryptography, is at present the best developed of these, and is available commercially. Its successful commercialization is partly because it requires only one qubit at a time. In contrast, quantum computation would require hundreds of qubits or more to exist simultaneously in an entangled state. Entangled states involving multiple photons,