

Optically induced organization of multiple zeolite *L* host particles. (See Woerdemann et al. on p. 40.)

Optics in 2010

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This special issue of *Optics & Photonics News* (OPN) highlights the most exciting peer-reviewed optics research to have emerged over the past 12 months. The areas covered in 2010 include guided waves, interferometric imaging, imaging, lasers, nonlinear optics, optical construction, optical engineering, optical magnetic interaction, plasmonics, quantum optics, spectroscopy, and ultrafast optics.

This year's issue includes 30 summaries representing the work of more than 130 authors from 14 countries. Submissions were judged on the basis of the following criteria:

- ▶ The accomplishments described must have been published in a refereed journal in the year prior to publication in OPN.
- ▶ The work should be illustrated in a clear, concise manner that is readily accessible to the at-large optics community.
- ▶ The authors should describe the topical area as a whole and then discuss the importance of their work in that context.

In 2010, for the first time, OPN has moved into the frontier of electronic publishing by incorporating multimedia elements into our December issue. We are pleased to offer nine summaries that are accompanied by videos. You can access them through our December digital edition, available at www.opnmagazine-digital.com/opn/201012, or through our main website, at www.osa-opn.org.

We plan to continue adding multimedia to our summaries from now on, and we'd love to hear your suggestions for how to improve our digital offerings. Please e-mail opn@osa.org with your feedback, or send us research summaries with multimedia that we can use to experiment for next year.

OPN and OSA would like to thank all the researchers from around the world who submitted summaries, as well as our panel chair and guest editors.

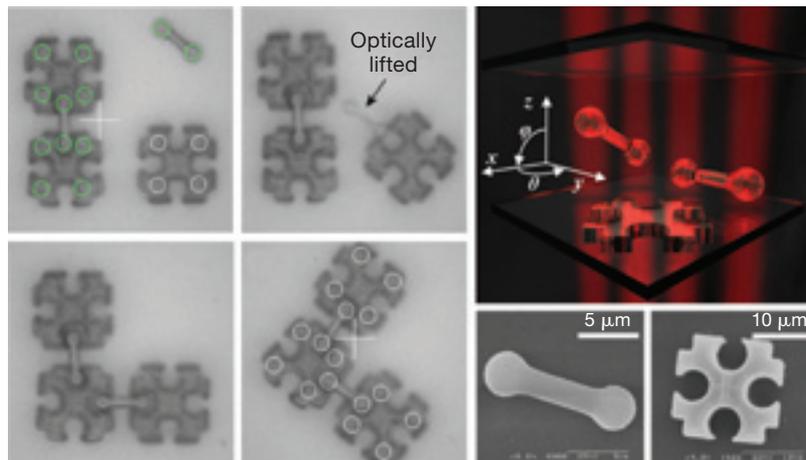
Optimizing Light-Matter Interaction on the BioPhotonics Workstation

A. Bañas, D. Palima, S. Tauro and J. Glückstad

Researchers' ability to manipulate microscopic structures in three dimensions has given rise to new biological applications.¹ Microscopic scaffolds that can be reassembled with multiple traps can simulate biological microenvironments.² With microfabrication processes such as two-photon polymerization, specially designed microscopic tools can be driven around biological samples for probing or sending stimulus. Similar to freely movable hand tools, 3-D controllable microtools can be used to trigger biological, chemical or mechanical reactions in a localized and controlled manner.

For many years, the manipulation of microscopic particles has been done with laser traps made of strongly focused beams from high-numerical-aperture (NA) objectives. Such traps rely on light intensity gradients and are called optical tweezers. The advent of computer addressable spatial light modulators enables a plurality of reconfigurable traps capable of translating simple beadlike structures, and rotating structures with multiple handles. Since tweezer-based traps need high-intensity regions and high NAs, the range of motion in the axial direction is very limited. We overcome this limitation using a counterpropagating beam geometry on our BioPhotonics Workstation.³

The BioPhotonics Workstation features real-time reconfigurable counter-propagating beam traps. Intensity patterns defining the optical traps are directly mapped into an addressable light-shaping module, minimizing computational overhead. Axial manipulation can be achieved by balancing the intensity ratios of the counterpropagating beams. This axial degree of freedom enables the flipping of planar microstructures and lifting puzzle pieces of reconfigurable microenvironments. Furthermore, the use of low NA objectives allows a wide range of axial manipulation and more freedom on the sample containers. Hence, advanced



Snapshots from a video illustrating optical microassembly of reconfigurable microenvironments using two-photon photopolymerized components.

Images are from ref. 2; they were featured in *Nature Photonics* in June 2009.

microspectroscopic or multiphoton characterization methods can be implemented independently in the side-geometry.⁴ However, these advantages come with a price of having less intense light, which is less stable in holding particles in place.

Recently, we demonstrated dynamic axial stabilization of counterpropagating beam traps.⁵ Computer vision tracks axial positions of multiple particles for use in a feedback algorithm that adjusts the respective counterpropagating beam

pair intensities as needed. This allows particles to be moved to, or held into, user-defined axial positions. Compared to the transverse trapping of optical tweezers, the axial feedback-stabilized counterpropagating optical traps in the BioPhotonics Workstation allow real-time rapid 3-D repositioning of particles over a large working volume.

By controlling multiple traps in 3-D, we are able to manipulate more complex structures with six degrees of freedom. Since we use an adaptive approach, the same setup can be used to trap particles of different sizes, overcoming the need for recalibrating the system. Manipulation works even with particles that have changing geometries similar to dividing cell colonies. ▲



Visit www.opnmagazine-digital.com to view the video that accompanies this article.

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