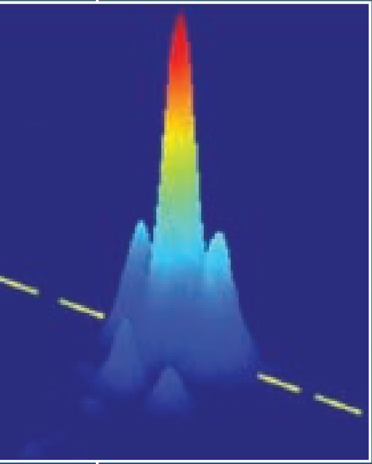
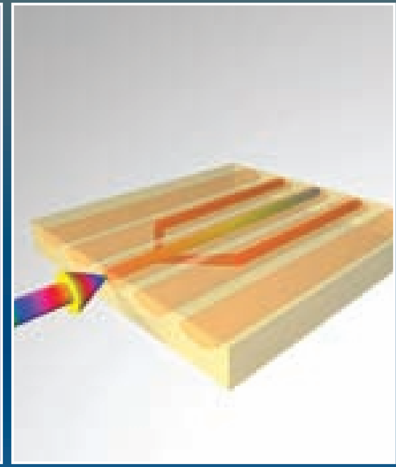
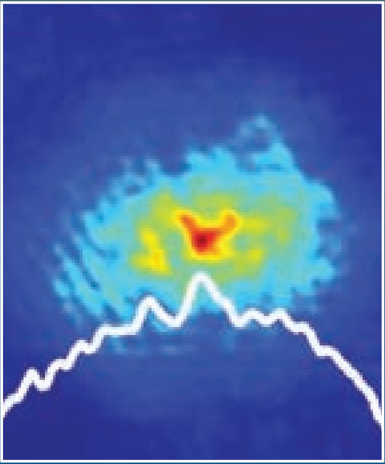
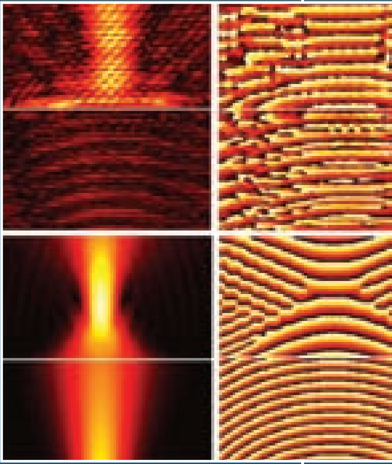
Optics in 2007









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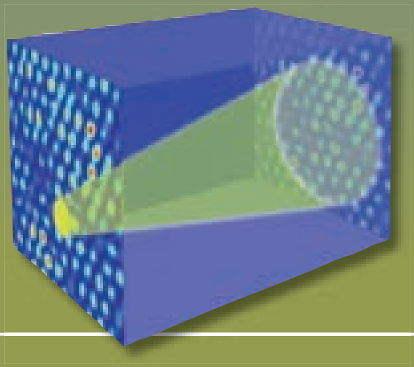

This special issue of *Optics & Photonics News* (OPN) highlights the most exciting research to emerge in the preceding 12 months in the fast-paced world of optics. "Optics in 2007" offers readers a unique opportunity to access, in a single source, summaries of cutting-edge optics research reported in the peer-reviewed press. The areas covered in 2007 include biophotonics, communications, holography, lasers, micro-optics, microscopy, nonlinear optics, photonic structures, plasmonics, quantum optics, slow light, solitons and ultrafast optics.

This year's issue comprises 30 summaries representing the work of more than 120 authors from 13 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.

Although OPN makes every effort to ensure that achievements in all optics subfields are recognized, there are no requirements in the selection process for inclusion of specific topical areas. When we receive a large number of submissions for a specific area, it is taken as evidence that the topic has been fertile ground for activity and research. OPN strives to ensure that engineering, science and technology are all represented.

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.

Parallel and Computer-Automated Optical Micro-Assembly

Jesper Glückstad, Ivan Perch-Nielsen, Carlo A. Alonzo,
Jeppe S. Dam and Peter John Rodrigo

The parallel assembly of minute components with sizes in the range of 1-100 µm remains to be an exciting scientific challenge within micro-mechanics. Research into real-time, massively parallel and three-dimensional micro-assembly schemes may lead to revolutionary developments of new and reconfigurable micro-opto-electromechanical-systems.

In particular, micro-assembly done within a liquid environment seems attractive to pursue, due to the fact that the undesirable effects of van der Waals and surface interactions can be kept at a minimum. Most contemporary techniques for micro-integration of submerged components rely on self-assembly schemes. However, micro-scale self-assembly in liquid has some constraints, such as the trade-off between how accurate micro-elements can be positioned to receptor sites and the yield or efficiency of the overall process.

To overcome this, the sample must go through a few re-circulations, and the template may require some mechanical agitation. To improve positioning accuracy of micro-components on a template, one may apply suitable matching of the geometrical shapes of the building blocks with their receptor sites.

Real-time reconfigurable arrays of a plurality of interactive optical traps are perhaps a more attractive alternative that can enable precise assembly of freely suspended microstructures. Multiple optical traps are capable of holding, positioning and rotating a plurality of mesoscopic objects in 3D.[1] In the past year, we have demonstrated the first all-optical, directed micro-assembly scheme.[2] We did this by tiling a plurality of microscopic structural elements on a planar substrate using real-time reconfigurable optical traps from a variant of the parallel optical manipulation schemes on which we have previously reported.[3,4]

The number of optical traps, their intensity profiles and spatial locations were all controlled either interactively or in an automated way using an advanced computer interface. Under computer-automated control, the system demonstrated the capability for fully autonomous search-and-collect routines without the need for any user-intervention.[5]

Our experimental demonstrations showed that optical traps of a few milli-watts can achieve good positional and rotational control of the assembled micro-structures. Efficient tiling also benefited from applying shape complementarity among the micro-puzzle pieces that have identical geometrical shapes and in-plane rotational symmetry. Finally, the puzzle pieces had an elongated aspect ratio so that the orientations were conveniently determined by an image analysis subroutine; this made it easy to orient the projected elongated optical traps. The micro-fabrication of the puzzle pieces was achieved by a standard femtosecond laser two-photon polymerization technique.

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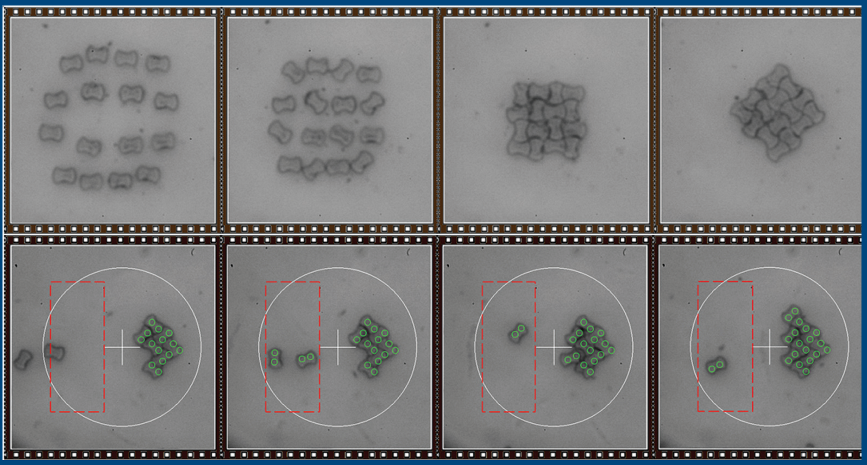

(Top) Micro-scale tessellation of 16 micro-puzzle pieces optically assembled in a parallel manner into a 4 x 4 tiling arrangement. Once assembled, all elements remain intact in the whole structure, which can also be displaced and rotated by the interactive group of optical traps. (Bottom) Computer-automated "hunt-and-collect" demonstration for joining micro-puzzle pieces. The dashed rectangle highlights the detection area, where incoming pieces from the left are automatically detected. Once detected, trapping beams with appropriate orientations and target trajectories are subsequently created.