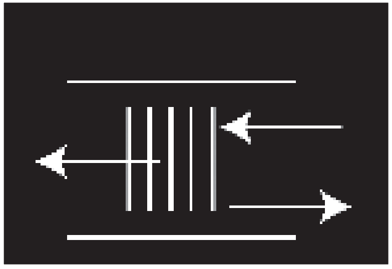
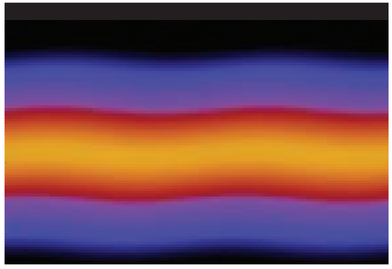
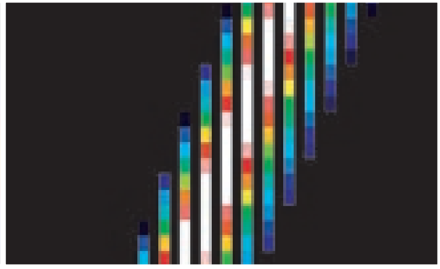
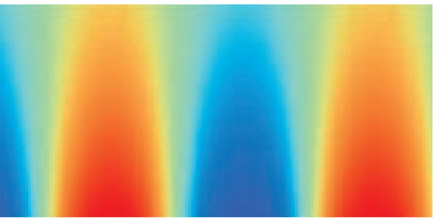






OPTICS in 2005

[Guest Editors]

Bob D. Guenther

Bob Jopson

R. John Koshel

Barbara Paldus

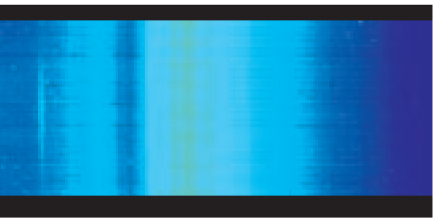
The December *Optics & Photonics News* (OPN) is a special issue that highlights the most exciting optics research to have emerged in the preceding 12 months. "Optics in 2005" offers readers a unique opportunity to access—in a single source—summaries of cutting-edge research that have been reported in peer-reviewed journals. The topics covered in this special issue cover a wide breadth, ranging from photonic structures to quantum information, and from optical engineering to ultrafast technology.

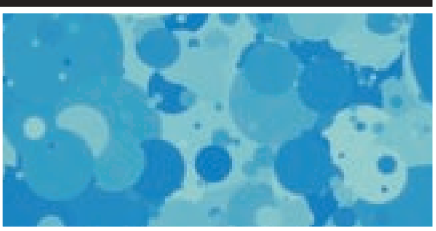
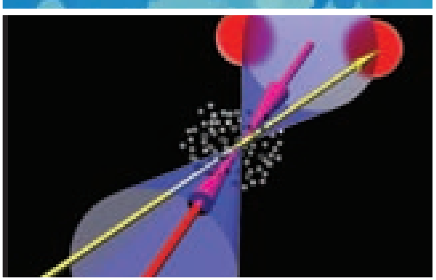
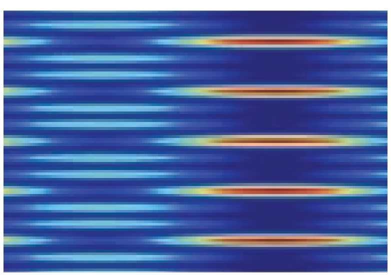
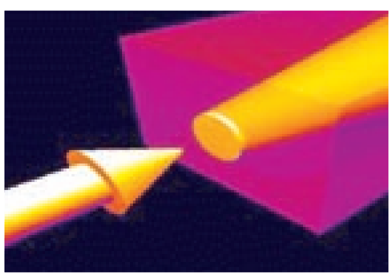
"Optics in 2005" includes 30 summaries that represent the work of more than 150 authors. They were chosen among 87 submissions from 20 countries. This year, as in previous ones, submissions were judged on the basis of the following requirements:

- The accomplishments described had to have been published in a refereed journal in the year prior to publication in OPN;
- The work had to be illustrated in a clear, concise manner that is readily accessible to the at-large optics community.

In addition, authors were asked to describe the topical area as a whole and to detail the importance of their work in that context. Although OPN makes every effort to ensure that it recognizes achievements in all optics subfields, our selection criteria do not require inclusion of any particular topical areas. When we receive a large number of submissions in a specific area, we take it as evidence that the topic has been fertile ground for research activity. OPN strives to ensure that engineering, science and technology are all represented. The number of papers we can accept each year is limited by the magazine's space requirements.

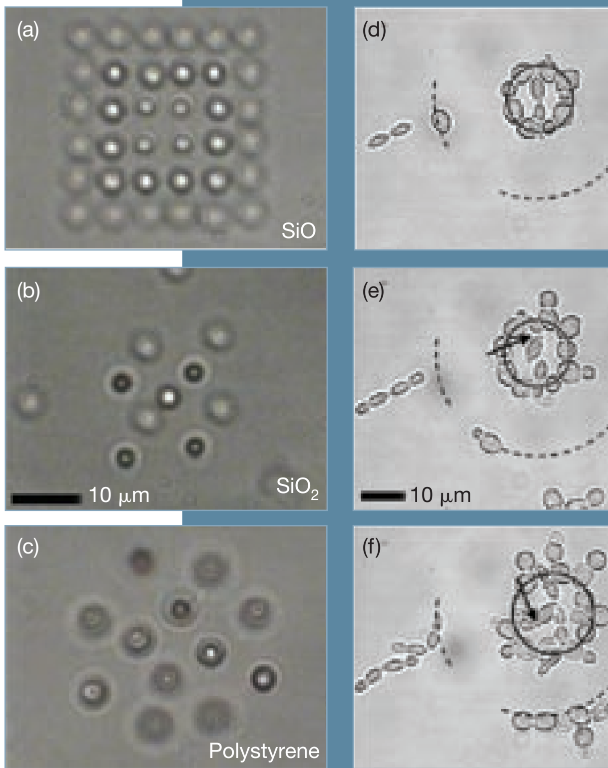
OPN and OSA would like to thank the multitude of researchers from around the world who submitted summaries of their peer-reviewed articles to "Optics in 2005." We would also like to express our sincere gratitude to the panel of OPN Editorial Advisory Committee members who vetted submissions to "Optics in 2005": Bob D. Guenther (Optics in 2005 Panel Chair), Physics Department, Duke University; Barbara Paldus, Skymoon Ventures, LLC; Bob Jopson, Lucent Technologies; and R. John Koshel, Lambda Research Corp. Thanks also to Angela Bailey for coordinating the review process.




Micro-biologic Applications of Real-Time Interactive 3D Optical Manipulation

Jesper Glückstad, Ivan Perch-Nielsen
and Peter John Rodrigo



(a-c) Real-time interactive 3D manipulation of micron-sized silica and polystyrene particles. (d-f) Growth inhibition with viable yeast cells *Saccharomyces cerevisiae* surrounding *Hanseniaspora uvarum* cells.

Over the past 15 years, lasers have proven to be efficient and versatile tools for manipulating objects ranging in size from a few tens of nanometers to several hundreds of micrometers. Until just a few years ago, virtually all optical manipulation was done by trapping particles inside a single, strongly focused continuous wave laser beam and subsequently moving them to a desired position by translating the laser focus—a technique now commonly called "optical tweezers."

In the beginning of the 21st century, researchers realized that much more versatile manipulation of molecules and particles was possible by using specially tailored three-dimensional crystal-like structures of light. Such sculpted light patterns have unprecedented potential for maneuvering mesoscopic objects; they have already been used successfully to organize small particles, including microbial cells, into desired patterns and to sort samples of particles according to their size.

Three-dimensional light structures can be created by modulating the spatial phase and polarization properties of the laser light. Scientists at Risø National Laboratory developed a particularly promising technique called the Generalized Phase Contrast (GPC) method.[1] Based on the combination of programmable spatial light modulator devices and an advanced graphical user-interface, the GPC method enables real-time, interactive and arbitrary control over the dynamics and geometry of synthesized light patterns.

In recent experiments, GPC-driven micro-manipulation has been shown to provide a unique technology platform for fully user-guided assembly of a plurality of particles in a plane, control of particle stacking along the beam axis, manipulation of multiple hollow beads and the organization of living cells into three-dimensional colloidal structures.[2,3]

This work illustrates that GPC-driven micro-manipulation can be used not only for the improved synthesis of functional microstructures but also for the non-contact and parallel actuation that is crucial for developing sophisticated opto- and micro-fluidic-based lab-on-a-chip systems.[4]

Using GPC-based optical manipulation, the groups at Risø National Laboratory and the Royal Veterinary and Agricultural University in Denmark were the first to discover that confinement could determine growth in a microbial ecosystem comprising two yeast species. That is, we provided evidence that confinement stress imposed by viable cells of one yeast species, *Saccharomyces cerevisiae*, on another yeast species, *Hanseniaspora uvarum*, inhibits growth of the latter.[5]

The mechanisms underlying this biophysical interaction are not yet known. Nor is it clear whether this phenomenon occurs in microbial ecosystems comprising bacteria and molds. In our future research, we plan to characterize the biophysical interactions that regulate microbial cell growth, including their underlying physiological mechanisms, cell mechanics in motile cells, the response of motile dictyostelium cells and the measurement of biochemical components that are part of the chemotaxis pathway. ◭

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