Optics in 2012

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This special issue of *Optics & Photonics News* highlights the most exciting peer-reviewed optics research to have emerged over the past 12 months. Our panel of editors reviewed close to 80 submitted summaries from scientists all over the globe. They selected for publication the 30 stories that they felt most clearly communicated breakthroughs of interest to the optics community. Eleven of those have multimedia components that you can access at www.opnmagazine-digital.com/opn/201212 or through our main web site, at www.osa-opn.org. Thanks to all who submitted summaries as well as to our panel of guest editors.

Online Extra: Visit www.osa-opn.org to watch a video highlighting the "best of the best" of our Optics in 2012 research findings.

Artist's interpretation of photophoretic light cages. (See Alpmann et al., p. 48.)

OPTICAL TWEEZERS

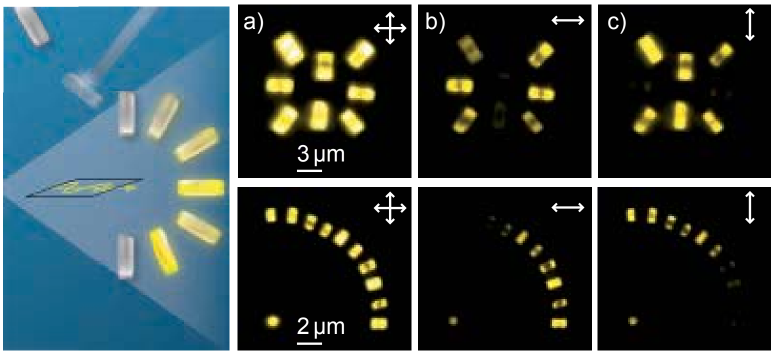
Creating Functional Microstructures with **an Optical-Tweezers Assembly-Line**

The hierarchical assembly of suitable molecules using non-covalent bonds can reveal exciting novel material properties and functionalities not achievable by their individual units. In particular, the microscopic organization of suitable containers that can accommodate molecular guests within their structure is a promising approach toward realizing materials with tailored functionalities.[1]

Complementary to chemical methods, holographic optical tweezers (HOT) enable an outstanding degree of control of the position and orientation of several building blocks at a single unit level.[2] With HOT, it is relatively straightforward to construct even complex assemblies of functional building blocks that are reversible and dynamically reconfigurable.[3] For advanced applications, however, a robust production process with high throughput is mandatory.

For this reason, we developed and demonstrated an optical-tweezers assembly-line (OTAL) based on HOT and a sophisticated microfluidic system.[4] HOT are ideally suited for trapping, selecting, moving, rotating and assembling individual building blocks with high precision. The microfluidic system is designed to provide a steady stream of suitable building blocks and to define the optimal chemical conditions for the supply and the construction site. The idea is to use several fluid flows in a low Reynolds number regime so they establish a laminar flow. Each fluid can be differently prepared to provide the optimal optical, physical and chemical conditions. Building blocks are typically selected in a feeding line and can easily be transferred across the laminar border to other channels. While the demonstrated OTAL consists of two lines, additional ones can easily be added.

With OTAL, it is possible to establish a very robust and versatile production process of functional microstructures and to construct structures with varying degrees of complexity, including 2-D highly structured monolayers and 3-D microtowers.[4] The most striking experimental results, however, were achieved with dye-loaded zeolite L crystals, which have a high number of strictly parallel nanochannels where suitable dye molecules can align in a regular way. Consequently, the fluorescence response of the loaded crystals is highly sensitive to the polarization properties of the excitation light. The geometrical arrangement of these functional building blocks can enable new functionalities. For example, the resulting intensity response does not only give an immediate qualitative measure of the excitation light polarization state but it even can be evaluated quantitatively and thus serve as a microscopic polarization sensor.[4] OPN



Permanent functional structures of DXP-loaded zeolite L container particles, created with the optical-tweezers assembly-line. (Top) Switchable illumination pattern, realized with eight crystals aligned with angles of 0°, 45° and 90° within a 2-D structure. Using unpolarized light or orthogonal states of linearly polarized light, one can switch the illumination pattern. (Bottom) Polarization wheel of 10 building blocks aligned on the circumference of a circle, sampling all angles within the plane with 10° steps. This allows quantitative measurement of the excitation light's polarization state. (a) Unpolarized fluorescence excitation. (b) Horizontally polarized excitation. (c) Vertically polarized excitation.

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

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