研究機関紹介

Collaboration between Southampton and Kyoto reveals new properties of light–matter interaction in glass

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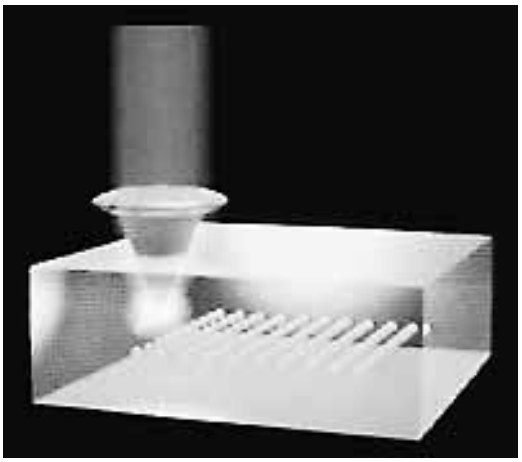
For over a decade, the international research collaboration between groups from the University of Southampton, led by Professor Peter Kazansky and Professor Kazuyuki Hirao Laboratory at Kyoto University, has linked two internationally leading research activities in the fields of glass science and optoelectronics. Together, the groups are exploring the effects of intense light fields produced by high power, short pulsed lasers on glass and other transparent materials to develop nano-scale 3 D photonic components and optical memories for high speed computing.

This long-lasting collaboration between Professor Peter Kazansky's group at the Optoelectronics Research Centre in Southampton, and Professor Kazuyuki Hirao's group in Kyoto started in 1997, when Professor Kazansky was invited as a visiting professor to Japan to participate in the HIRAO Active Glass project. During this activity a peculiar anisotropic propeller shape scattering was observed in Ge-doped silica glass. This observation paved the way to another intriguing result: the discovery of self-organized nano-grating formation during laser machining. This is the smallest nanostructure ever created by light inside transparent material. The



discovery triggered numerous research activities all over the world related to self-organized nano-gratings formation in transparent materials. Currently, nano-grating is widely studied to apply them in the areas of nano-fluidics for 'lab-on-a-chip' applications, high-density 5 D re-writable memory for optical computing and security marking.

The scientists from both universities did not stop there. The next step was the observation of "quill writing", a peculiar phenomenon of femtosecond laser direct writing. In essence, this means that the isotropic material modification depends on the laser writing direction and the laser beam acts as a quill. Such counter-intuitive finding led to understanding that spatio-temporal characteristics of light, previously neglected largely by scientific community, are of high importance in laser-matter interaction.

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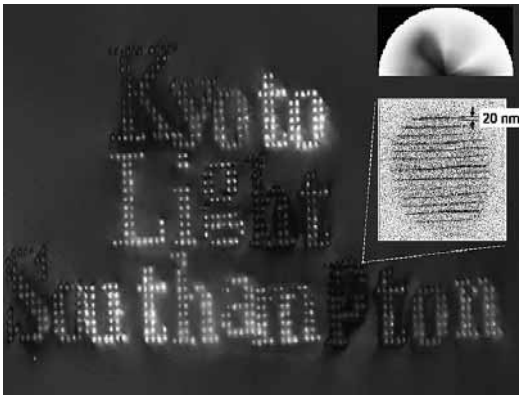

Recently, researchers at Southampton and Kyoto have presented the first evidence of anisotropic photosensitivity, revealing a new property of interaction of light with matter which could have a significant impact on optical data storage, laser machining and surgery. Photosensitivity, the term given to describe an object's response to light, is a material property which is relevant to many phenomena and applications, from photosynthesis and photography to optical data storage and ultrafast laser writing. Until now, it has been a common belief that, in an isotropic medium, if you change the polarization of an isotropic laser beam, photosensitivity and the corresponding light-induced material modifications do not change. However, the researchers have discovered that a single intense beam with a tilted pulse front tilt interacts with the glass differently depending on the light polarization.

Scientists involved in this collaboration are intending to continue this adventurous and potentially high impact research in optics. 'These results are significant and we anticipate that our discoveries could lead to new opportunities in material processing, optical manipulation and data storage,' comments Professor Peter Kazansky. 'Here at Southampton and Kyoto we have the facilities and expertise to make these opportunities a reality.'