VIEW FROM... JSAP SPRING MEETING 2010

The season of inspiration

A scheme for polishing glass to an angstrom-scale surface quality and an all-optical pH measurement technique were just two of the elegant ideas presented at this year's spring meeting of the Japan Society of Applied Physics.

Noriaki Horiuchi

Although spring in Japan is most famous for its beautiful (although brief) country-wide display of pink cherry blossom, it is also well-known by scientists for being the time of the annual spring meeting of the Japan Society of Applied Physics (JSAP). This year, the 57th spring meeting was held from 17–20 March 2010 at Tokai University, located around 50 km southwest of Tokyo, and featured approximately 4,300 presentations. Here's a brief discussion of some of the topics that caught our attention at this year's gathering.

The first was concerned with the surface smoothness of mirrors and lenses, which is an essential consideration in many optics experiments. In recent years, the advent of lasers operating with ultrashort pulses, extremely high peak powers or wavelengths in the extreme ultraviolet has proved to be problematic for optical components, which are easily damaged under such conditions.


NORIAKI HORIUCHI

Tokai University had the honour of hosting this year's spring meeting of JSAP.

It is well known that the optical durability of a material is one of the crucial factors in preventing optical damage, but surface smoothness is also a critical factor. Now, the firm Sigma Koki has developed a polishing technique that makes it possible to control surface smoothness at the subnanometre scale, thus dramatically improving the optical damage threshold of polished optical components. In the traditional grinding of convex parts, dust arises at the interface between the surface and the polishing disk, causing unwanted scratches that lower the damage threshold.

The research group at Sigma Koki has found that optical near-field etching can be used to solve this problem. Its polishing technique is based on chemical etching enhanced by optical near-field localization. The group described how quartz — a common material for a mirror or lens — was polished to a roughness <0.4 nm by etching it with Cl_2 gas while illuminating it with second-harmonic light of 532 nm from an Nd:YAG laser. The process dramatically increased the damage threshold of the mirror far beyond that of optical mirrors finished by conventional polishing. The firm says that this technique is applicable to the polishing of flat and curved surfaces, and will be highly valuable to researchers using high-intensity laser sources.

Regarding new laser sources, a team led by Yasuhiko Arakawa from the University of Tokyo claimed to have observed lasing from a 3D photonic crystal for the first time. In principle, such photonic crystals should allow highly efficient lasing with ultralow excitation thresholds. Lasing in a two-dimensional photonic crystal has already been reported, but spontaneous emission was not suppressed in the vertical direction as it required a further photonic bandgap. The group made their 3D photonic crystal from 25 layers of 2D photonic crystal, each 150 nm thick. The sample size was 10 μm × 10 μm × 3.75 μm, with a defect area in the centre of the 13th layer in which quantum dots of InAs/Sb:GaAs were grown. The experiment was carried out at a temperature of 7 K, with the photonic crystal excited by 8 ns, 25 kHz pulses from a 905 nm laser. Lasing was observed at a wavelength of 1.2 μm for excitation powers above 1.29 μW.

Looking at other research fields such as chemistry and biology, Toshihiko Kiwa of Okayama University reported that his group have used femtosecond laser pulses to measure pH values. The group first developed a sensing tip composed of a sapphire substrate covered with thin layers of Si (150 nm) and SiO_2 (275 nm). Terahertz radiation was generated from the Si layer when the sensing tip was irradiated with pulses from a femtosecond laser (centre wavelength of 790 nm, pulse width of 100 fs and repetition rate of 82 MHz). The terahertz intensity was proportional to the local electric field modified by the presence of silanol radicals, which are linked to proton concentration and thus to pH. This method is label-free and does not require any pH-sensitive fluorochrome. The all-optical measurement technique is suitable for a temporal change of pH. The group reported that the pH measurement range was 1.68–10.01, and that the spatial resolution was at the submicrometre scale. Their technique may allow the investigation of biochemical reaction mechanisms inside plants or mitochondria.

The science and ideas presented at this year's spring meeting of JSAP were just as inspiring as the season's cherry blossom. ❐

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