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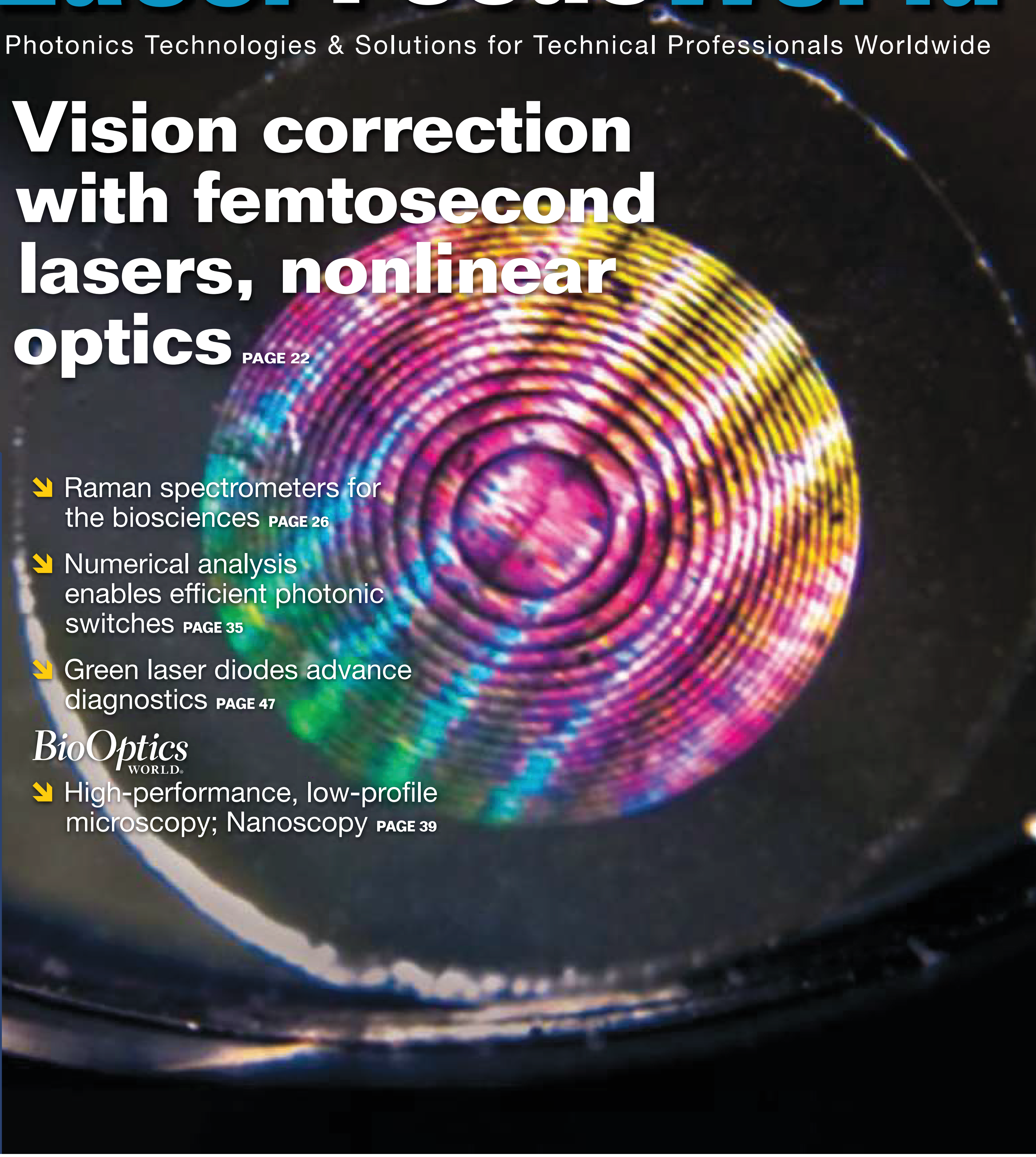

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NOVEL SPECTROSCOPY

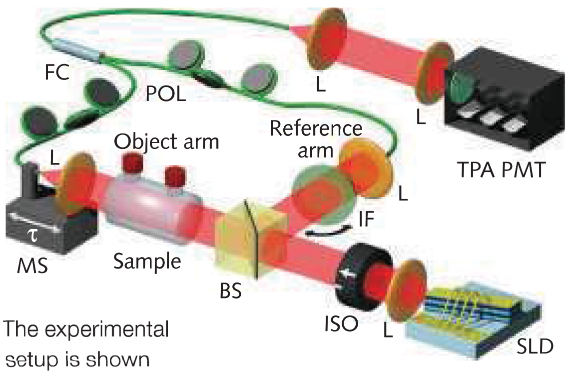
Superluminescent diode enables first thermal-light 'ghost spectroscopy' demonstration

In the ghost imaging process, a detector analyzes the correlated intensities of two light beams (only one of which interacts with the object) and forms what is called a "ghost image," as the detector never actually sees the object. Performed using entangled photons, it was thought that the phenomenon was purely because of quantum effects. However, in 2009, it was shown that ghost imaging could be achieved using true thermal light. Since then, numerous sources have been used to demonstrate the ghost imaging process.

The conversion of ghost imaging from the spatial to the frequency or wavelength domain can also be demonstrated using entangled photons. However, researchers at the Technical University of Darmstadt (Darmstadt, Germany) are now the first to have demonstrated this "ghost spectroscopy" capability using true thermal light from a superluminescent laser diode (SLD).[1]

Broadband, high-spectral-resolution requirements

As in ghost imaging, two-beam interference of signal photons (that illuminate the object) and idler photons are sent through a monochromator and recorded by a spectrally resolving detector. The reconstruction of the frequency-dependent absorption of the object can then be reconstructed by correlating the detector signals as a function of the reference frequency. It is thought that ghost spectroscopy had not been achieved using a thermal light source because of the inability to find a sufficiently broadband source that could achieve high time correlation.



The experimental setup is shown for the ghost spectroscopy demonstration using a superluminescent laser diode source.

Indeed, the TU Darmstadt researchers found that the emission from a quantum-dot SLD does offer high spectral resolution through second-order wavelength-wavelength correlation of the SLD signal and reference beams. Cross-correlation of the two intensities of the beam are able to create a ghost spectrum of a sample of chloroform.

In the experiment, the SLD light source has a center wavelength of 1228 nm and a full-width half-maximum of 33 nm (see figure). In a nonlinear two-photon absorption (TPA) process, photons need to be absorbed within the Heisenberg uncertainty timeframe for the ultrafast intensity correlation of the signal and reference beam to take place.

Even though the detector never sees the chloroform sample, correlation of the signal and reference arm produces a chloroform spectrum centered at roughly 1214 nm.—*Gail Overton*

REFERENCE

1. P. Janassek et al., *Phys. Rev. Appl.*, 9, 2, 021001 (Feb. 2018).