incoherent and would require both a slit and a collimating mirror. In principle, the signal-to-noise ratio obtainable would be similar to that of a grating instrument at the same resolution. Whether or not it will be possible to exploit the potentially higher resolution will depend on the luminance of the source, but the high wavenumber accuracy will nevertheless remain an important advantage.

We should expect many further results from this exciting new instrument, both in its present form at Synchrotron SOLEIL and in new applications elsewhere with different light sources. ❐

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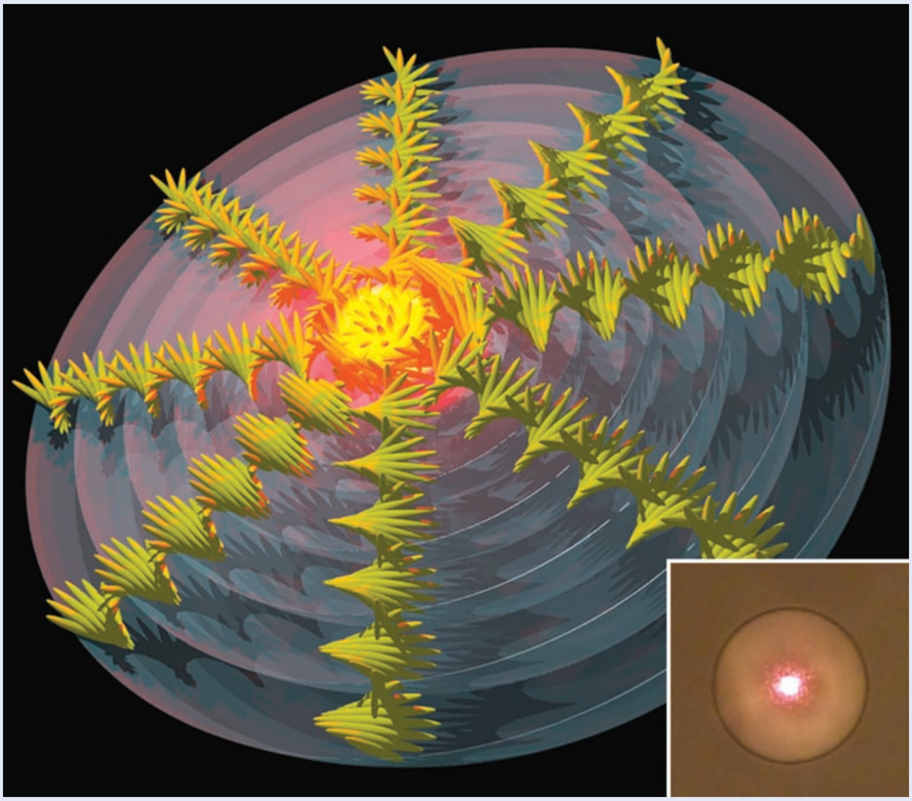
LIQUID CRYSTALS

Tiny tunable 3D lasers



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Integrated photonics applications require lasers that are cheap, highly tunable, can emit light in all directions and have low thresholds, narrow linewidths and ultrasmall mode volumes. The recent findings of Matjaž Humar and Igor Muševič from the J. Stefan Institute and University of Ljubljana in Slovenia may fulfil these requirements (*Opt. Express* **18,** 26995–27003; 2010).

Instead of building a solid-state 3D microlaser, the researchers opted for a soft-matter approach. "Soft matter has an inherent natural ability to self-assemble into a variety of structures that are potentially interesting for photonic applications," explained Muševič.

Humar and Muševič created their microlaser by placing a 15–50-µm-diameter microdroplet of cholesteric liquid crystals doped with a laser dye into an isotropic carrier fluid. Dispersing the microdroplet in an immiscible fluid such as glycerol allowed it to spontaneously self-assemble into an aspherical shape because of surface tension. Strong periodic modulation of the refractive index induced by the chirality of the cholesteric liquid crystals caused the formation of a multilayered spherical Bragg resonator. This microresonator can be thought of as hundreds of concentric shells of alternating refractive index.

Optically pumping the microdroplet with external pulses caused the photonic bandgap in the Bragg resonator to concentrate the light emitted from the dye molecules inside the microdroplet, thereby emitting monochromatic light in all directions. Specifically, lasing was observed at ~600 nm with a linewidth of ~0.1 nm at a threshold of ~1.8 mJ cm^{-2} when a 1 ns pumping pulse from a Q-switched frequency-doubled Nd:YAG laser was used to uniformly illuminate a 40-µm-diameter microdroplet. The average output power was reported to be 0.05 mW at a repetition rate of 200 Hz.

The dependence of the lasing wavelength on the helical period of the cholesteric liquid crystals allowed it to be tuned simply by varying the temperature of the system. The researchers demonstrated a reversible temperature tuning of ~35 nm at 3.5 nm K^{-1}. They also pointed out that the lasing threshold was dependent on the number of layers in the microdroplet, corresponding to the *Q*-factor of the microcavity and hence to the diameter of the microdroplet. The smallest lasing-allowable diameter in the work was 15 µm.

According to the researchers, millions of identical microlasers can be produced in a fraction of a second, simply by mixing two different immiscible fluids. This is almost impossible to produce in a solid-state device — a clear advantage of the soft-matter approach.

"I expect that the long-term impact of these cheap, disposable and easy-to-produce microlasers as coherent, omnidirectional light sources might be for soft-matter integrated photonic circuits. In the short term, they might be useful for imaging and sensing," said Muševič.

RACHEL WON