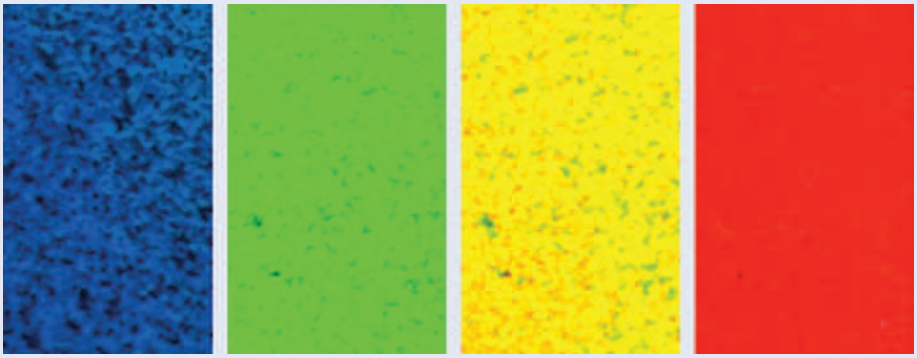
PHOTONIC CRYSTALS

Bridging the visible

Photonic crystals are periodic dielectric structures that can be used to prohibit, confine or control light propagation in a particular wavelength band (known as the photonic bandgap). Consequently, they are an important building block for all-optical integrated circuits. The ability to tune their photonic bandgap dynamically across a wide wavelength range is highly desirable, but it has proved difficult to achieve to date. Now, Tsung-Hsien Lin and co-workers from Taiwan and the USA have demonstrated optical tuning of the bandgap of a liquid-crystal blue-phase (BP) photonic crystal across the entire visible spectrum (*Adv. Mater.* http://dx.doi.org/10.1002/adma.201300798; 2013).

BP photonic crystals are easy to fabricate — a three-dimensional periodic cubic lattice with dimensions of several hundred nanometres can be created through self-organization in a liquid crystal. The researchers found that the photonic bandgap of a compound consisting of chiral azobenzene (1.7%), commercially available nematic liquid crystal E48 (54.3%), chiral dopants S811 (29%) and R811 (15%) could be tuned over a wide wavelength range by irradiating the compound with blue light.



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The compound exists in two phases, BP I and BP II, whose photonic bandgaps lie in different regions of the visible spectrum. A reversible transition between these two phases can be driven by either temperature changes or exposure to blue light (wavelength, 408 nm). The compound initially exhibited Bragg reflection at a wavelength of approximately 470 nm. During irradiation with blue light (intensity, 13 mW cm^{-2}), the reflection band of BP II was observed to shift continuously to longer wavelengths (from 470 nm to 520 nm), until a phase transformation to BP I occurred. On further exposure to blue light, the reflection band of BP I continuously shifted to longer wavelengths (up to 630 nm). After 15 s of irradiation, the reflection band of BP I no longer shifted; rather, it remained constant at 630 nm. Although natural thermal relaxation from BP I to BP II took a few hours, it could be accelerated by irradiation with 532 nm light (intensity, 24 mW cm^{-2}). Increasing the concentration of the light-driven chiral switch in the mixture from 1.7% to 3.5% broadened the optical tuning range of the photonic bandgap from 470–630 nm to 420–710 nm.

NORIAKI HORIUCHI

LASER PHYSICS

Turbulent times

Researchers show that the breakdown of temporal coherence in a fibre laser has strong similarities with the onset of turbulence in fluids. Establishing a conceptual connection between these different systems can offer new perspectives for both fields.

Fatih Ömer Ilday

To observe the transition between laminar and turbulent flow, it is only necessary to go to the kitchen sink and watch how the water flow changes as the tap is increasingly opened. Yet, despite the pervasiveness of turbulence and its long research history (dating back to Reynolds' pioneering work in the 1880s[1]), the seemingly straightforward question of under exactly what conditions turbulence develops has eluded a precise answer. Indeed, the famous and brilliant physicist Richard Feynman described turbulence as "the most important unsolved problem of classical physics" half a century ago[2].

Writing in *Nature Photonics*, Elena Turitsyna and co-workers[3] describe the laminar and turbulent regimes of fibre laser operation, which resemble the equivalent regimes in fluid flow in a pipe, and identify a new mechanism that plays an important role in the transition to turbulence. In particular, they show that during the transition, dark and grey solitons proliferate, form clusters and repeatedly interact with each other, eventually destroying the temporal coherence of the laser. This mechanism appears to be similar to a recently uncovered mechanism in fluid dynamics in which clustering of spatially localized pockets of chaotic flow, known as 'puffs', are thought to be responsible for the onset of fluid turbulence in pipes[4].

The identification of analogous dynamics in lasers and fluids is more than just a scientific curiosity — laser dynamics potentially represents a convenient experimental platform for studying fundamental questions in turbulence. One example of how analogous