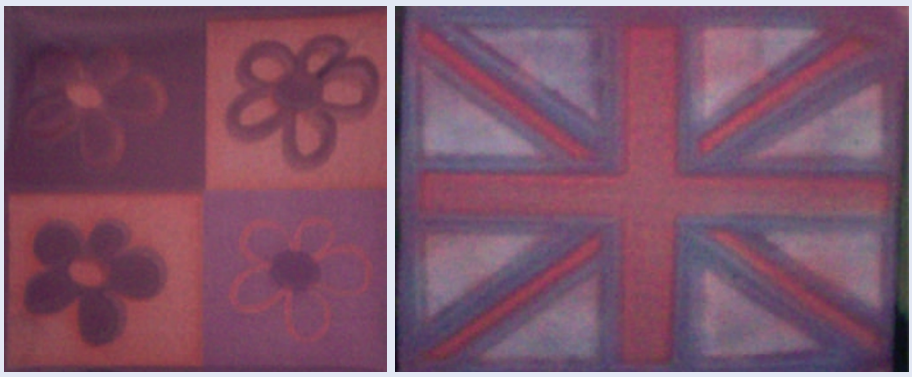
OPTICAL FUNCTIONAL MATERIALS

Self-erasing images

Images and messages that automatically erase themselves after a set period of time have long been a popular feature of spy films. Although this idea is already used for toy 'water pens', a more practical method could help alleviate society's reliance on paper and benefit the environment by reducing waste and the demands of recycling.

Now, researchers at Northwestern University, USA, have shown that such a rewritable medium can be achieved using thin, flexible organogel films that contain embedded metallic nanoparticle 'ink' (*Angew. Chem. Int. Ed.* **48,** 7035–7039; 2009). Rafal Klajn and co-workers used inks containing either gold or silver nanoparticles coated with mixed self-assembled monolayers of dodecylamine and photoswitchable azobenzene-terminated thiol, 4-(11-mercaptoundecanoxy) azobenzene. When exposed to UV light, the *trans*-azobenzene groups coating the nanoparticles undergo isomerization to form *cis*-azobenzene, which has a large dipole moment. As a result, the nanoparticles aggregate into so-called supraspherical assemblies (clusters), and thus become visible. The colour of the assemblies depends on the duration of UV irradiation.



For example, as exposure time increases, gold-nanoparticle inks evolve gradually from red to pale blue, and silver-nanoparticle inks change from yellow to violet. By moving a 'light pen' (of intensity 10 mW cm^{-2}) over a film at 3 mm s^{-1}, one can write an image. Remarkably, multicolour images can be created using only a single nanoparticle ink by varying the irradiation dose over different regions of the film. Typical exposure times depend on the colour required and are in the range of 0.8–10 s, using 365-nm light at an intensity of 10 mW cm^{-2}.

The images fade with time in the absence of UV light as the nanoparticle assemblies gradually break up, a process that typically takes a few hours but can be accelerated by heating the film. Interestingly, the optical response of these carefully engineered films does not change for at least 300 rewrite cycles.

One idea is that such rewritable 'paper' based on these new films could be useful for storing sensitive data, or for temporary information such as self-expiring bus tickets.

NORIAKI HORIUCHI

SEMICONDUCTORS

Excitonic lattice control

Customizing the refractive index of wells and barriers in a periodic array of quantum wells yields a way to control the reflectivity and dispersion of an excitonic lattice. The result is a new method for slowing or modulating light.

Hyatt M. Gibbs and Galina Khitrova

Light interacts strongly with matter in a quantum well (QW) when its frequency is close to the resonance of an exciton — a quasiparticle composed of an electron in the conduction band bound to a hole in the valence band. This is an effect similar to the coherence that occurs between the excited and ground states of an atom, when the atom is subjected to resonant excitation. This light–matter interaction becomes much stronger when the spacing between QWs arranged in a periodic array is exactly half the exciton wavelength, because the excitonic polarizations in the QWs are in phase and therefore interfere constructively; that is, the Bragg condition is satisfied. This excitonic lattice (Fig. 1a) results in a high reflectivity around the exciton resonance wavelength, and can be used for the 'switching' of light.

On page 662 of this issue[1], a new tool is reported for manipulating the propagation of light through such a structure by introducing an additional periodicity that interacts with the excitonic lattice. So far, studies have only involved periodic quantum wells (PQWs) that have almost identical refractive indices for their QWs and barriers (Fig. 1b). In the study of Goldberg *et al.*, however, the refractive indices of the QW and barrier are different, resulting in a non-resonant photonic crystal (Fig. 1c). This one-dimensional (1D) photonic crystal has a stopband — a frequency band that does not allow signals to pass through — at some other wavelength, which can be seen as a peak in reflectivity, and this occurs even if the PQW spacing differs from half the exciton wavelength. When the QW spacing is adjusted so that the stopband is close to the exciton wavelength, the Bloch modes of the photonic crystal band edge interact