Fig. 1, which can give rise to strong Bragg reflection. This occurs in a band of wavelengths $\Delta\lambda = P\Delta n$, where $P=2d$ is the pitch, d the spatial period, and Δn the birefringence. The first-order wavelength $l = P(n_{eff}^2 - \sin^2 q)^{1/2}$, where q is the angle of incidence, and n_{eff} the effective refractive index. The electron micrograph of Fig. 2 shows the periodic structure of a cholesteric liquid crystal quenched to the glassy state.

Although the microscopic origins of pitch are still a subject of study[5], it is well known that the pitch and the reflected colours depend on temperature. Liquid-crystal temperature indicators are based on this effect. For their full-colour recording on cholesteric films, Tamaoki *et al.* have synthesized a low-molecular-weight cholesterol derivative, which, on cooling, shows a cholesteric liquid-crystal phase in the temperature range 87–115 °C between the isotropic liquid and the crystalline solid. Their recording technique consists of first forming a coloured image on their cholesteric liquid-crystal film by cooling it to different temperatures at different points, then rapidly cooling to a temperature below its glass-transition temperature of about 80 °C. The rapid cooling prevents crystallization, and preserves the cholesteric structure and the colour. The system can be repeatedly rewritten. Coloured 'pixels' and sample images recorded by this method are shown in Fig. 3.

Two technologically relevant questions about cholesterics are how to adjust the pitch, and how to keep it constant once it has the right value. As well as being sensitive to temperature, the pitch depends on the concentration of chiral constituents. High-resolution spatial patterning of pitch and colour can be achieved by ultraviolet irradiation of samples with photosensitive chiral dopants[6]. But although this technique has great potential for display applications, it is not suitable for rewritable recording because it is not reversible. Alternative ways of locking the pitch are by polymerization[7,8], or by using a polymer network to stabilize the cholesteric structure[9]. In its 'Designo' programme, Mercedes–Benz uses cholesteric liquid-crystal polymers as special-effects paints for its cars. Polymer-stabilized low-molecular-weight cholesterics, with an internal network of photopolymers, are used in bistable reflective display applications[3]. But again, these schemes are not suitable for rewritable recording by altering the pitch because of their irreversibility.

The optical properties of cholesterics change slightly on quenching from the liquid crystal to the glass; the reflection band is typically broadened and shifted because of a decrease in pitch due to thermal contraction, and because of the change in the refractive indices (T. Kosa, personal communication). Unique features of Tamaoki and colleagues' material are its extremely broad reflection band, which probably originates in a strongly anisotropic molecular polarizability and allows the realization of colours over virtually the entire visible spectrum; and its high glass-transition temperature, which allows the glass to remain stable at room temperature.

In their paper, Tamaoki *et al.* discuss the possibility of laser-addressing their material by using laser heating due to absorption. Laser writing, where the local structure of the material is altered by light from a laser, has been carried out in a variety of liquid crystals, including polymer-stabilized cholesterics[10,11], but by exploiting different mechanisms. Tamaoki and co-workers' system offers the possibility of laser-writing high-resolution full-colour images on solid cholesteric glass films, for image recording and for high-density storage of optical information.

Another promising application of room-temperature cholesteric glasses is in optical elements for high-power laser systems. Elements in use today confine the liquid crystal between glass plates[4], which may bow and distort the wavefront. Because the new cholesteric glass is solid, optical elements using Tamaoki and colleagues' material could be set on a single substrate to overcome this problem. □

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Ice sheets

On the shelf

Over three-quarters of Earth's fresh water is locked in the great ice sheets covering Greenland and Antarctica. The stability of these ice sheets is the single largest unknown factor in attempts to predict how sea level may rise in the future, as even a small change in the mass balance of this ice would result in a significant change in global sea level. The recent break-up of some ice shelves on the Antarctic Peninsula (see *Nature* 379, 328–331; 1996), and the recognition that large changes have occurred over the past few decades in ice streams feeding the West Antarctic ice sheet (*Science* 279, 689–692; 1998), has generated a great deal of public interest in the problem.

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Although the break-up of ice shelves does not directly affect sea level (by definition, ice shelves are the floating parts of ice sheets, and so already displace an equivalent volume of sea water), it could be that their disintegration would seriously affect the discharge rate of grounded ice from inland regions.

Elsewhere in this issue (*Nature* 391, 778–780; 1998), Christopher Doake and colleagues describe an attempt to establish a stability criterion for ice shelves through modelling of the two northern sections of the Larsen ice shelf on the Antarctic Peninsula. Shown here is the northern section of this ice shelf, Larsen A, which disintegrated within a few days in January 1995 (just before this photograph was taken); in the upper left-hand corner can be seen the edge of Larsen B, which is still intact, although retreating. Through finite-element computer modelling of the strain rates for these two sections of ice shelf from 1986 to 1997, Doake *et al.* discovered that only the initial and final ice front positions of Larsen A were stable, and that if Larsen B were to retreat only a few more kilometres it too is likely to disintegrate.

The hope is that these stability criteria can be used elsewhere, to help distinguish which ice shelves are in danger of collapse.
John VanDecar