Daily Telegraph "Week in Science" article (500-word limit)

Now You See Them, Now You Don't

They're in your brain and in the messy gunk at the bottom of the soap dish. Your grunge sweatshirt might even change its colour with temperature because of them. Better known for their appearance in digital watches, calculators and laptop computers, they are...liquid crystals!

Liquid crystals are a distinct phase of matter and deserve their rightful place next to solids, liquids and gases. However, unlike other phases, the liquid crystal phase can only occur in organic materials formed of cigar-shaped molecules. Such materials behave strangely: they melt from a crystal to a liquid crystal at one temperature and then melt again into a conventional liquid at a higher temperature. Liquid crystal phases exist in a number of geometric forms; the simplest, the *nematic* phase, is characterised by the fact that the molecules all point in a specific direction but are free to jostle around, as in a liquid (diagram 1).

Although discovered in 1888, liquid crystals received little attention until the 1970s when scientists at the Defence Research Agency in the United Kingdom first realised their suitability for use in portable displays. The most basic liquid crystal display (L.C.D) is called a *twisted nematic* device. This is the type of display found in digital watches and calculators. The twisted nematic device consists of a thin layer of nematic liquid crystal sandwiched between two plates. The plates are *polarising*, meaning that they only let light through if it vibrates along a certain axis. In the OFF (bright) state, the liquid crystal molecules lie parallel to the plates. The directions in which the molecules point at the inner surface of each plate are perpendicular, so that the molecules effectively *twist* in orientation from one plate to the other. The interaction between liquid crystals and light in this particular geometry means that any light that enters is able to reach the back plate and reflect from a mirror behind it, giving a bright output. However, when a voltage is applied to the device (the ON state), the liquid crystal molecules align with the electric field so that they point *towards* the plates. In this geometry, light cannot pass through the device, and so the output is dark. Alphanumeric characters can be generated by laying many of these miniature devices side by side in a grid and applying a voltage to the appropriate segments.

Displays have advanced a lot since the days of the first digital watch. Much of the research since then has concentrated on producing liquid crystal devices that can respond fast enough to switch on and off at the 50Hz frame rate used in televisions. Indeed, prototype flat-screen televisions have already been demonstrated and could soon be an everyday sight hanging from the living room wall.

Liquid crystal applications are not limited to displays; "Global Hypercolor™" sweatshirts take advantage of the fact that some liquid crystals only reflect light of a particular wavelength, which depends on the temperature…in this case, body temperature!

The list of applications is long. From ultra-fast camera shutter systems to opaque wall panels that become transparent at the flick of a switch, research into liquid crystals is now thriving. New and exciting uses continue to be found for this peculiar phase, ensuring that liquid crystal technology will be with us well into the next millennium. And mankind is not alone in reaping the benefits of liquid crystals; it has recently been discovered that spiders store their silk in liquid crystal form!