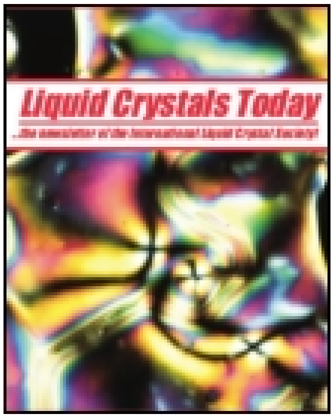

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Industry & applications news

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NEWS

Industry & applications news

Simple microlenses

A group of researchers based at Centre National de la Recherche Scientifique in Toulouse, France, have developed a fabrication technique for microlenses using a cholesteric liquid crystal (LC) [1,2]. Microlenses are increasingly used for many applications. They have been used for focusing to increase detector efficiency; are widely used in lab-on-a-chip optical devices; and are an integral component of a plenoptic camera, which creates pictures that can be refocused after they are taken.

Previous fabrication techniques for microlens arrays involve multiple steps, making them time-consuming and expensive, and are often limited to glass substrates. The new technique utilises the self-assembly of a blend of cholesteric LC oligomers, allowing fabrication to be performed in a single step. The array is formed by annealing the material, which is then fixed by rapid quenching. This process can be carried out on a variety of substrates, including flexible ones. The technique forms a structure of polygons, each behaving as a Bragg grating, with the period of the array determined by the pitch of the LC. This structure resembles the iridescent coatings found on many beetles.

The optical properties of these microlenses are wavelength-tunable. Their shape and focusing properties can also be simply modified by changing the annealing time. While this technique satisfies the demand for a cheap, tunable method of fabrication, the group also hopes to explore the use of dyes to extend the technique to the fabrication of microlaser arrays.

On the road to magnetic displays

The response of LCs to electric fields is effectively used to couple light and electricity in a wide variety of devices, including displays and spatial light modulators. LC properties can also be influenced by magnetic fields; however, this has limited practicality due to the extremely high fields (~1 Tesla) required. Researchers at the University of California, Riverside, have recently demonstrated a liquid crystalline material that can be controlled with weak magnetic fields of only ~1 mTesla. The switching speeds achieved of 10 ms are comparable to many electrically switched LCs found in commercial displays [3].

The LCs that have been developed at the Yin Lab are an aqueous dispersion of magnetic iron oxide nanorods [4]. The molecular orientation of these nanorods can be manipulated by a weak magnetic field, with the nanorods aligning themselves along the field direction. The transmittance of polarised light is affected by the orientation of the nanorods in the same way as standard LC molecules. These magnetic nanorods are much larger than molecules in commercial LCs, leading to some interesting properties. Orientation of these rods can be fixed using lithographic techniques to solidify the dispersing medium. The team believes that thin films of the material can be easily fixed in orientation, having possible applications in anti-counterfeiting.

A main benefit of using magnetic, rather than electric, fields to control a LC are that it can be done 'remotely' – without the contact required by an electrode. While electrode-free devices would be beneficial in many applications, there are drawbacks with the current material. The absorption of visible light by the nanorods themselves may limit uses, and the researchers hope to reduce this absorption either by modification of the material or by switching to a transparent magnetic material. It is also unlikely that we will see high-resolution displays using this technique, since the magnetic fields used cannot be easily controlled with fine resolutions.

The incoming quantum dot display boom

The use of quantum dots (QDs) to enhance liquid-crystal display (LCD) technology is something of a hot topic in the display industry. Traditional LCDs are transmissive and require a backlight that is then filtered into RGB colours to produce the image. Much light is wasted in this scheme, and so, a lot of energy is required to make the final picture bright enough for the viewer. This drawback with LCDs has led organic light-emitting diode displays (which are emissive) to take the lead in the market in terms of contrast and colour reproduction.

In a QD-enhanced display, the white backlight of an LCD is replaced with a blue light. A film of QDs placed in front of the backlight absorbs the blue light and proceeds to emit red or green light. The wavelength of light emitted is determined by the size of the QD. This produces a display with less light leaking between colours, and a far smaller energy requirement than colour filtered LCDs, leading to brighter displays with more vibrant colours.

One of the more prominent examples of this technology is the quantum dot enhancement film (QDEF) that has been developed by California-based Nanosys Inc. in collaboration with 3M. The most recent iteration of QDEF was presented at the American Chemical Society meeting in August, held in San Francisco [5]. The main challenge is preventing the breakdown of the QDs, which can happen when exposed to water or air. 3M tightly seal the QDs in a film which can easily be incorporated into current LCD manufacturing processes. Recent demonstrations of their technology have also led them to win a third best in show award at the 2014 Display Week, organised by the Society for Information Display [6].

This technology has been showcased in the Amazon Kindle Fire HDX, available to consumers for almost a year, which has received high praise for its display. 3M/Nanosys have announced partnerships with Asus to bring this technology to the laptop market [7], and it now seems that QDEF is being rapidly deployed in high-end LCD televisions. Hisense has recently demonstrated its line of QD enhanced displays at IFA 2014 in Germany, which should be released in early 2015. With hardware giants LG and Samsung also looking to begin mass production with QD technology, 2015 should be the year to see a boom in QD-enhanced devices.

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