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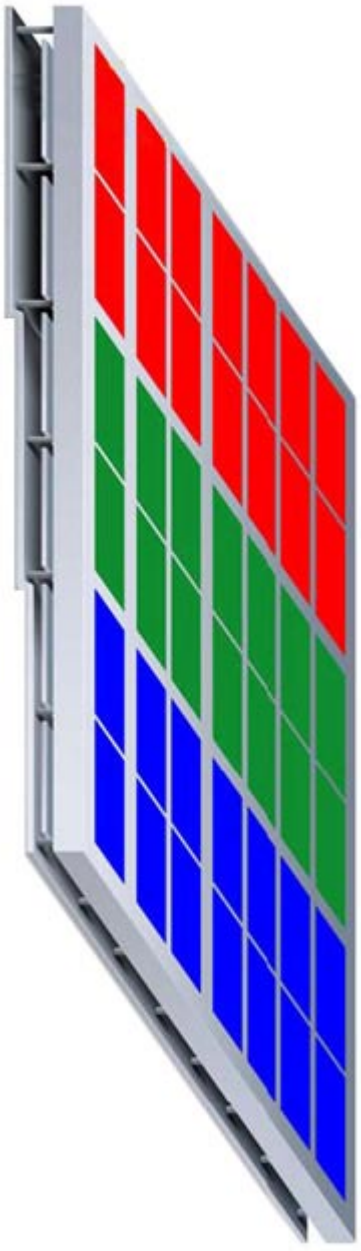
E-Paper Displays Video

A new type of MEMS-based electronic paper for cell phones is fast enough to show video.

By Duncan Graham-Rowe



Mechanical displays: Micro

electromechanical systems (MEMS) devices make it possible to display colored video images on a novel electronic-paper display.
Credit: Qualcomm MEMS Technologies

Multimedia

- See how full-color video images are displayed on an electronic-paper display.

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A novel electronic-paper display developed by Qualcomm can deliver high-quality video images, making it more versatile than other e-paper technologies. The display employs microscopic mechanical switches that turn pixels on and off at rates more than fast enough to display video.

The first versions of the display will be monochrome; one is featured in an Audiovox Bluetooth headset, released this week. A two-color display will be used next year in a phone made by the Chinese phone company Hisense. Full-color versions will follow.

Like ordinary paper, e-paper displays are designed to be reflective, making them much easier to view in a range of different lighting conditions, such as bright sunlight, than are traditional displays, such as backlit LCDs. The other main advantage is that they are bi-stable, meaning that once they have been switched to a state, they will hold that state without requiring an electrical current. The benefit of this is that they use considerably less power. These features make them ideal for applications such as signs and electronic books, including Sony's eBook reader.

In most e-paper displays, however, pixels switch on and off too slowly to display video, says James Cathey, vice president of business development for Qualcomm MEMS Technologies, based in San Diego. Indeed, other e-paper technologies can take longer than half a second to respond. Such slow switching can lead to "ghosting," in which moving subjects blur. In contrast, pixels in the new Qualcomm display can switch in just tens of microseconds--fast enough to produce sharp video images. Cathey says that this ability to use the displays for video could make e-paper less of a niche technology and suitable for more mainstream multimedia displays for mobile devices like cell phones.

The new display technology uses a novel method for producing color. The method employs mechanisms that are similar to the ones that give films of oil on water a colorful sheen, says

André Arsenault, a chemist at the University of Toronto, and cofounder and chief technology officer of Opalux, a Toronto-based e-paper startup.

When light hits a film of oil, it splits, with some reflecting and the rest passing through the oil before being reflected off the surface of the water. The light reflecting off the oil is slightly out of phase with the light reflecting from the water. As a result, light waves interfere with each other, with some wavelengths being reinforced and others canceled out. The distance between these surfaces determines which colors are amplified and which are canceled. Films of oil of a certain thickness, for example, would amplify green light while canceling out red and blue light, making the oil appear green.

In the display, each pixel consists of several color-specific cells that mimic the film of oil on water. Each cell is made up of two reflective layers, one on top of the other. The top layer is only partially reflective, allowing some light to pass through it and bounce off the second surface. In each cell, the gap between these surfaces is spaced so that constructive interference occurs for only one specific range of wavelengths, causing them to amplify a single primary color while canceling out other colors. To create a full-color display, each pixel is made up of three different types of cells, each having a different-size gap between the layers that reflects red, green, or blue.

Each cell can be turned off by bringing together the two layers using an electromechanical switch. (When there is little space between the layers, no visible light is amplified, making the cell appear black.) The switch moves after a pulse of voltage and stays in place until another pulse moves it back. As a result, the display is bi-stable, using little energy except to change the image.

By combining different sets of colored cells as subpixels, researchers can get any color of the spectrum, says Cathey. These MEMS devices are very robust, he says, and have been demonstrated to be reliable for more than 12 billion cycles.

"I personally think this technology is very cool," says Arsenault. But because of the fabrication processes used to create MEMS devices, there is a constraint on how big such displays can be made, he says, which is the reason that Qualcomm is targeting small mobile displays.

What's more, the energy savings will only apply when the display is used to view static, not video, images,

says Johan Feenstra, one of the founders of Liquavista, a spinout from Philips Research, based in Eindhoven, the Netherlands, which is also developing e-paper capable of video rates. "Bi-stability is only useful when you have an application where you don't change the image often," Feenstra says.

For video, this isn't the case because the pixels have to be switched on and off almost continuously, says Guido Aelbers, chief operating officer at Polymer Vision, also in Eindhoven. "The moment you go to high speeds, you lose the low-power advantage," he says.

Even so, both Aelbers and Feenstra believe that having video capabilities as well as color opens up a much bigger marketplace for e-paper displays. But with LCD technology constantly improving and costing less, it could well give the new display a run for its money, says Aelbers.