Study brings us step closer to rollable, foldable e-devices

October 31 2012, by M.b. Reilly

UC research is bringing closer the e-Sheet, shown here in a photo illustration. e-Devices will one day be as thin and as rollable as a rubber mat. Credit: Noel Gauthier

(Phys.org)—Research out this week from the University of Cincinnati brings industry and consumers closer to several improvements in e-Readers and tablets, including a simpler and more colorful way to make rollable and foldable devices. Some day, you may be able to fold up your iPad and put it in your pocket.

The next generation of electronic displays – e-Readers, smartphones and tablets – is closer thanks to research out today from the University of Cincinnati.

Advances that will eventually bring foldable/rollable e-devices as well as no pixel borders are experimentally verified and proven to work in concept at UC's Novel Devices Laboratory. That research is published today in the journal *Nature Communications*.

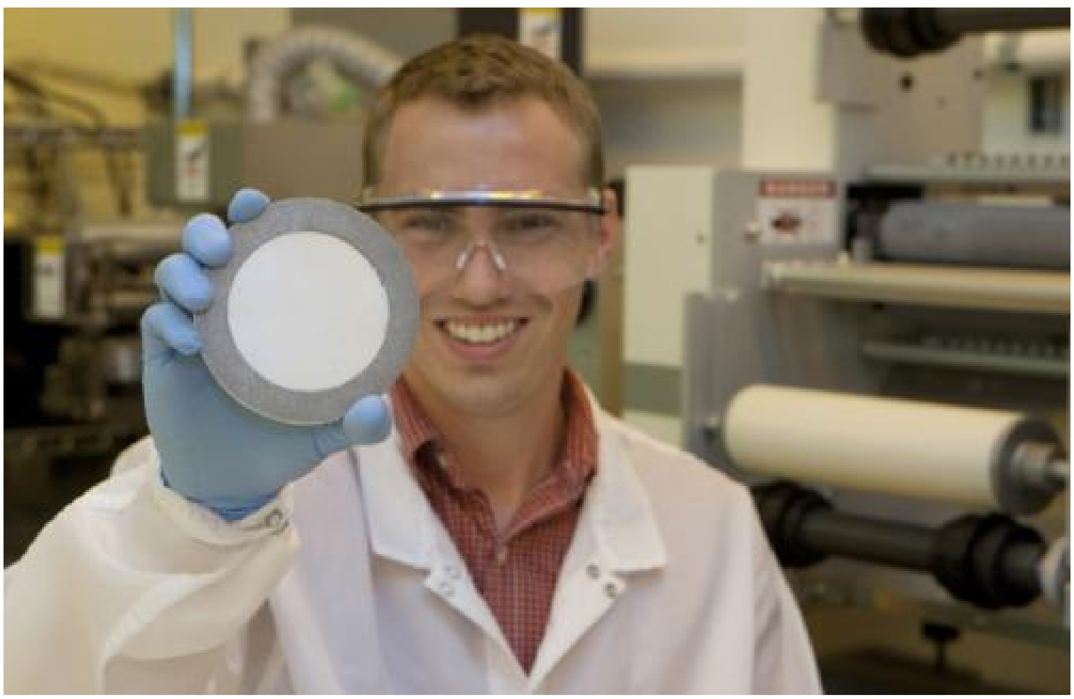
The UC paper, "Bright e-Paper by Transport of Ink through a White Electrofluidic Imaging Film," is authored by College of Engineering and Applied Science doctoral students Matthew Hagedon, Shu Yang, and Ann Russell, as well as Jason Heikenfeld, associate professor of electronic and computing systems. UC worked on this research with partner: start-up company Gamma Dynamics.

FOLDABLE e-DEVICES CLOSER THANKS TO ELECTROFLUIDIC IMAGING FILM

One challenge in creating foldable e-Paper devices has been the device screen, which is currently made of rigid glass. But what if the screen were a paper-thin plastic that rolled like a window shade? You'd have a device like an iPad that could be folded or rolled up repeatedly – even tens of thousands of time. Just roll it up and stick it in your pocket.

The UC research out today experimentally verifies that such a screen of paper-thin plastic, what the researchers refer to as "electrofluidic imaging film," works. The breakthrough is a white, porous film coated with a thin layer of reflective electrodes and spacers that are then subjected to unique and sophisticated fluid mechanics in order to electrically transport the colored ink and clear-oil fluids that comprise the consumer content (text, images, video) of electronic devices.

According to UC's Hagedon, "This is the first of any type of electrowetting display that can be made as a simple film that you laminate onto a sheet of controlling electronics. Manufacturers prefer this approach compared to having to build up the pixels themselves within their devices, layer by layer, material by material. Our proof-of-concept breakthrough takes us one step closer to brighter, color-video e-Paper and the Holy Grail of rollable/foldable displays."



Matthew Hagedon with electrofluidic imaging film. The white, plastic film, ten times thinner than a sheet of paper, is in a rigid frame for support during lamination into a display. The goal is a large roll of film that can be laminated onto electronics. Credit: Lisa Ventre

NO PIXEL BORDERS

Importantly, this paper-thin plastic screen developed at UC is the first among all types of fluidic displays that has no pixel borders.

In current technology, colors maintain their image-forming distinctiveness by means of what are known as "pixel borders." Each individual pixel that helps to comprise the image necessary for text, photographs, video and other content maintains its distinct color and does not bleed over into the next pixel or color due to a pixel border. In other words, each individual pixel of color has a border around it (invisible to the eye of the consumer) to maintain its color distinctiveness.

This matters because pixel borders are basically "dead areas" that dull any display of information, whether a display of text or image. Leading electronics companies have been seeking ways to reduce or eliminate pixel borders in order to increase display brightness.

Said UC's Heikenfeld, "For example, the pixel border in current electrowetting displays, which prevents ink merging, takes up a sizable portion of the pixel. This is now resolved with our electrofluidic film breakthrough. Furthermore, our breakthrough provides extraordinary capability to hide the ink when you don't want to see it, which further cranks up the available brightness and color of the display when you do want to see it. With a single, new technology, we have simplified manufacturability AND improved screen brightness."

In 10 to 20 years, consumers will see foldable/rollable e-Devices with magazine-quality color, viewable in bright sunlight but requiring low power, as shown in this photo illustration. UC research is bringing these devices closer. Credit: Noel Gauthier

FOLDABLE e-DEVICES AS ENVIRONMENTAL ELECTRONICS

Expect that the first-generation foldable e-devices will be monochrome. Color will come later. Eventually, within 10 to 20 years, e-Devices with magazine-quality color, viewable in bright sunlight but requiring low power will come to market. "Think of this as the green iPad or e-Reader, combining high function and high color without the weight of a heavy battery, readable out in the sunlight, and foldable into your pocket," said Heikenfeld.

The device will require low power to operate since it will charge via sunlight and ambient room light. However, it will be so "tough" and only use wireless connection ports, such that you can leave it out over night in the rain. In fact, you'll be able to wash it or drop it without damaging the thin, highly flexible casing and screen.

This latest proof of concept research verifying the functionality of electrofluidic imaging film builds on previous research out of UC's Novel Devices Laboratory. That previous research broke down a significant barrier to bright electronic displays that don't require a heavy battery to power them.

Currently, faster, color-saturated, high-power devices like a computer's liquid-cystal display screen, an iPad or a cell phone require high power (and, consequently, a larger battery), in part, because they need a strong internal light source within the device (that "backlights" the screen) as well as color filters in order to display the pixels as color/moving images. The need for an internal light source within the device also means visibility is poor in bright sunlight.

The new electrofluidic imaging film is part of an overall UC design that will require only low-power to produce high speed content and function because it makes use of ambient light vs. a strong, internal light source within the device.

Provided by University of Cincinnati

Citation: Study brings us step closer to rollable, foldable e-devices (2012, October 31) retrieved 21 May 2024 from https://phys.org/news/2012-10-closer-rollable-foldable-e-devices.html

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