Flexible screens expected to inspire a host of new devices

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Later this year, Hewlett-Packard researchers say, they expect to deliver to the U.S. Army a working prototype of what they're calling a "Dick Tracy wristwatch" - a lightweight, wearable device that soldiers in the field can use to view digital maps and other data on a flexible plastic screen that won't shatter or crack like glass.

Though it will be spartan by design, researchers say HP's prototype could be one of the first in a new wave of products incorporating flexible electronic displays. Freed from the constraints of a rigid glass screen, designers could one day build flexible plastic displays into clothing, wall coverings and perhaps even e-readers or tablets that can roll up like a

newspaper.

"You can start thinking about putting electronic displays on things where you wouldn't ordinarily think of having them," said Nick Colaneri, a scientist and director of the Flexible Display Center at Arizona State University. "How about a stack of thin displays that I can peel off and stick on things, sort of like a pad of Post-It notes?"

Long before those hit the market, however, flexible plastic displays will provide tablets, smart phones and other portable computers with big screens that weigh less and are far more durable than today's models, said Carl Taussig, director of advanced display research at HP Labs in Palo Alto, Calif.

"Unlike glass, plastic doesn't break when you drop it on the floor," said Taussig, whose employer has a vested interest in electronic displays, as the world's biggest seller of personal computers.

Experts have long predicted a big future for flexible displays. The Defense Department has funded efforts to develop lightweight screens that soldiers can use in hostile environments. A host of computer-makers and electronics companies are working on commercial applications.

"We're quite bullish on this market," said Jennifer Colegrove, vice president for emerging technologies at DisplaySearch, an industry research and consulting firm, which estimates that sales of flexible displays will grow from $85 million in 2008 to more than $8 billion in 2018.

But technical issues have made it a long and sometimes frustrating quest. Mountain View, Calif.-based Plastic Logic showed off a prototype e-reader with a flexible display last year, dubbed the "Que," only to announce later that its commercial release would be delayed indefinitely.

Standard components for liquid crystal displays, used in most portable computers today, generally require a rigid glass to keep images from being distorted. Traditional displays also depend on transistors that are embedded in glass through processes that involve temperatures high enough to melt or distort plastic.

Taussig's team at HP, however, is working with plastic film that is both lighter and thinner than glass, and which can be stored in rolls. Their method resembles, in a sense, the way newspapers are printed from giant spools of paper.

The process starts with rolls of plastic that has been treated with thin layers of metal and other material. The plastic is run through a press that imprints a microscopic, three-dimensional pattern, which can then be etched to create transistors on the film. These can transmit instructions to electrically charged particles or diodes contained in a second layer of plastic, which then displays text or images.

While it's not yet ready for commercial use, Taussig said he's convinced the roll process can be far cheaper than current "batch" methods for making glass displays, which require vast clean rooms and precision robotics to keep each pane from being damaged in production.

Other groups in Taiwan and elsewhere are developing manufacturing processes in which layers of transistors are laid down on sheets of plastic temporarily bonded to a pane of glass. Colaneri said display manufacturers could adopt that approach while using much of their existing equipment.

But eventually, Colegrove said, HP's "roll" approach may be a less expensive process for making flexible screens in large volume. Currently, she added, the cost of the glass display might be $30 to $40 for a typical e-reader like the Amazon Kindle that sells for $139.

The prototype that HP is building for the Army also takes advantage of low-power features associated with E Ink, the technology used in most e-readers. As a result, Taussig said the device will be able to run on the power from a small, flexible solar panel that can be part of the wristband.

E Ink uses black and white particles with opposite electrical charges, floating in tiny capsules of liquid. Electrical signals cause the particles to form a pattern of letters, words or other images. The display requires little power because it has no backlighting and uses electricity only to create a new page.

While that's good for static displays, such as maps or blocks of text, Taussig said his team is also working with organic light-emitting diodes, or OLEDs, to build flexible displays capable of showing color and video. That will take more time, he added, although he said HP has proved the concept with very small displays.

Other companies are working on the same goal. Samsung touted a 4.5-inch flexible prototype using OLED technology at this month's Consumer Electronics Show in Las Vegas. Sony and LG have also shown off flexible display prototypes in recent months.

The first consumer products using flexible displays will likely have the same rigid frames as today's laptops and tablet computers, Colaneri said. Even if the screen can bend, he explained, researchers have not yet developed flexible processors and other computer components.

Next will come products with screens that are curved or molded permanently into innovative shapes, he added, while a screen you can roll up and stuff in your pocket may be several years away.

FLEXIBLE DISPLAYS:

-Advantages: Flexible plastic displays can be thinner, lighter and more durable than glass, which can lower manufacturing costs, increase product life and make new designs possible.

-Applications: First will likely be smart phones, tablets and notebook computers. It could eventually be used in clothing, wall displays and other products that can be curved or rolled.

-Challenges: Requires new manufacturing processes and transistor materials. Hewlett-Packard is working on a method for imprinting and etching spools of plastic film; others are working with sheets of plastic temporarily bonded to glass.

ONE WAY OF MAKING FLEXIBLE DISPLAYS:

Hewlett-Packard's process starts with a spool of plastic film, about 50 microns thick, which has been coated with metal and other materials.

The plastic is run through a press, much like a roll of newsprint is sent through a printing press to make a newspaper, except the plastic is stamped with a microscopic, three-dimensional pattern before it is rolled onto another spool.

In similar fashion, the film is then etched to create the layer of transistors that form the lower plane of the display. The transistors will convey digital signals to charged particles or diodes in a top layer, creating symbols or images.