Originally Published MPMN June 2007

NEED TO KNOW

For Display Applications, the Future is Flexible

Shana Leonard

Engineers are striving to achieve flexible displays by using plastic and stainless-steel substrates, rather than glass.

It seems like an idea conjured up using movie magic. But while a thin flexible-display version of a newspaper was featured in the 2002 sci-fi thriller, Minority Report—set in the year 2054—the concept isn't just a novelty in a Steven Spielberg film. Rapidly approaching the transition from movie magic to engineering breakthrough, a new breed of flexible displays is in development that researchers claim could be bendable, wearable, or even rolled up like a newspaper.

Piloting this futuristic venture is the Flexible Display Center at Arizona State University (FDC; Tempe, AZ; www.flexdisplay.asu.edu). Established through funding by the U.S. Army in 2004, the center is focused on the development of flexible-display technology for military use. Flexible displays will enable soldiers to receive and deliver real-time information in a lightweight, rugged, low-power, possibly wearable package capable of functioning in harsh field environments.

While the immediate goal of the center and its numerous government and industry partners is rooted in military applications, long-term plans of the FDC include acting as a catalyst for flexible-display technology development and commercialization in other markets, among them healthcare. Flexible displays could come in handy in hospitals and point-of-care environments where lightweight mobile devices would be desirable for nurses and physicians, for example.

Within the walls of its 250,000-square-foot facility, the FDC is concentrating its efforts on reflective technology and organic light-emitting diode (OLED) displays. Reflective technology allows users to view a low-power display more clearly in bright light than in dim light—solving a problem typically encountered with consumer products such as cell phones and personal digital assistants. Providing high information content, full-motion video, and full-color displays, OLEDs are considered the next step up from liquid-crystal displays (LCDs), according to Shawn O'Rourke, the FDC's director of operations. "What's different about those [OLEDs] compared to LCDs is they typically use 30 to 40% less power and they have very good color and [create] a very good-looking display. The efficiency of an LCD is actually only about 5%—from the light that's actually in the back to the light getting to the user's eyes. OLEDs change that," he adds.

To actualize flexible technology, engineers diverged from the common use of glass and silicon to stainless-steel and plastic substrates for the backplane. The incorporation of these materials ensures a more rugged package than those backplanes made from glass, which is often brittle, heavy, and vulnerable to cracking.

But in order to achieve the payoff of a flexible display, the FDC has had to adapt conventional manufacturing processes to suit limitations imposed by making the electronics on plastic. Since plastic stretches when film is put down, layer-to-layer alignments are offset—a factor that must be taken into account. Moreover, plastic cannot withstand as high temperatures as glass or silicon; however lower temperatures can produce defects.

Despite these quandaries, the FDC is making substantial progress in producing a flexible display. Recently, the center accomplished the development of a four-inch-diagonal AM-QVGA reflective electrophoretic display with a high-performance, low-temperature amorphous silicon backplane.

"We've identified a critical path in the technology and we're really pushing forward in developing transistors on plastic right now for displays, and there is a future past that," O'Rourke says. "Transistors on plastic actually provide a much broader capability and open the doorway for numerous other microelectronics applications."