Flexible Electronics: Are we there yet?

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Many of us have been monitoring the flexible electronics field for several years now. SVC member interest follows antireflection coatings, low-e, barrier coatings for plastic, flex touch screens, transparent conductors for plastics and new deposition methods. The transparent conductor researchers became interested when there was worry over indium tin oxide (ITO) conductors cracking after multiple flexing on plastic. Likewise, we became very involved with protective coatings as organic LEDs or OLEDs developed.

As a result, SVC has developed the WebTech TAC (Technical Advisory Committee) in 2012 directed towards higher added value products.

In February, the FlexTech Alliance hosted 2012 Flex, Flexible Electronics & Displays Conference and Exhibition, in Phoenix, Arizona. In its eleventh year, the 2012 show had 57 exhibitors and over 560 attendees. These numbers represented a 20% growth in attendance, with an increase in exhibitors by 30% from 2011 and included some Fortune 500 companies in attendance. Notable exhibitors included DuPont, EMD-Merck Chemical, DuPont Teijin, Corning, Samsung, Sony, Microsoft, 3M, Ohio Gravure, PARC, Solutia, Sharp, IBM, HP, Lockheed-Martin, Saint-Gobain, and Mark Andy, Inc. Collaboration was very high with many groups discussing techniques and properties of materials. I met the principals of the Flex Tech Alliance at Semicon last year in a session on “Xstream Electronics”. The Flex Tech Alliance comprises a group of about 90 companies working on flex electronics and has evolved from what was formerly known as the US Display Consortium, with some funding from the U.S. Army Research Labs. The Alliance has funded over 100 projects with a total of US$220M combined public and private funds. Michael Ciesinski, President and CEO of FlexTech Alliance opened the conference. Dr. Jennifer Richlin, Chief Technologist with Air Force Research Labs, gave a keynote lecture telling us we are now in the “Organic age” of electronics, with the coupling of organic, biological and inorganic technology into a flexible package. Probably one of the biggest improvements to the field is the availability of flexible backplanes. Plastic Logic has their e-paper back plane on the market. This is driving electronics for displays which has taken many years to develop using lower temperature deposition processes for plastic substrates. Also, simple flexible memory and thin film batteries and solar cells are becoming available. We see in flexible electronics a merging of very fine printing technology with electronics. Processes can include air based inkjet printing, screen printing and some vacuum processes, with specialized processing equipment. Flex electronic goes into applications such as smart cards, smart bandages, flexible organic LED displays, identification and RFID tags. There seems to be two branches of development, one headed toward inexpensive printing electronics on paper direction; the other is looking at high quality, high information content displays with very thin form factors and low weight for hand held electronics such as cell phone displays. The market for flex electronics is estimated to be US$5.4B (2012), growing to US$60B (2022), according to Raghu Das, IDTechEx. The largest growth is in OLED displays (US$4B in 2012). The markets are OLED displays, sensors, inks, flex PV, E-paper, inorganic electroluminescent devices, signage, printed batteries and memory. On the research side, there are very strong developments in electronic inks, low melting point glassy systems, and nanomaterials, including CNTs or carbon nanotubes. Graphene and graphene derivatives such as graphene oxide, are popping up as well. Heraeus showed their Clevios™ PEDOT:PSS polydiathiol polymer conductor.

Corning is working on a form of R2R flexible glass for use as a display material. Willow Glass has a thickness of 0.1mm with sheet width up to 1 m. The sheet can withstand 500 ºC processing temperatures higher than most plastics. A roll to roll simulation is shown on YouTube http://www.youtube.com/watch?v=uXQEpVRtGtw

Arizona Grand Resort, Phoenix, was the venue for the 2012 Flex Tech Conference. (Photo courtesy of Carl Lampert)
Very few integrators seem to be putting products together just yet. The U.S. Army is interested in smart bandages that can monitor the vital signs of a wounded soldier and smart sensing prosthetics. The Flextech Alliance helps fund projects via DARPA and other government advance research organizations.

Steve Abramson, CEO of Universal Display, showed organic LEDs on flexible plastic as displays and as light emitters. Michael McCreary, Deputy CTO at E Ink, showed various versions of eReader including color. The E Ink eReader with Amazon has really put lightweight readers on the market and is causing a revolution in the way book content is marketed. Recently, I was amazed when entering a national book store to see – not books as I walked in the door – but images of books on eReaders available for downloading. Recently, at the SID Display Week in Boston, LG showed a flexible reader using a plastic E Ink display sheet.

John McCooey with DuPont showed a range of printing techniques, including flexography and gravure, to make flexible circuits. Kevin James with Mark Andy, Inc. contended that the printing industry needs to focus on functional printing on the finest quality scale. He commented that it is possible to fool the eye but not the electrons. David Barnes with Biz Witz, felt that container packaging and wearable displays were some of the first product applications. Also, low information content toys are a target as well.

The Flex Alliance gave out FLEXI Innovation Awards to PARC (Xerox) for their thin film transistor technology and Thin Film Electronics ASA for their innovation on addressable memory using PARCs transistor design. The Center for the Advancement of Printed Electronics (CAPE) at Western Michigan University (WMU) was given a FLEXI R&D award for their Roll to Roll educational development program using gravure, inkjet, flexography, screen printing and CVD techniques. WMU is known for their materials database for electronic printing. The Center for Organic Photonics and Electronics (COPE) at Georgia Institute of Technology received the Technology Leadership in Education award.

So, are we there yet? The goals are getting clearer on the horizon, and the materials and process makers are running a fast race, but so far the market pull is weak with some push from E-readers. To paraphrase Milton Keynes, “The difficulty lies not so much in developing new ideas as in escaping the old ones.”