Tech Talk

Fine Lines in High Yield (Part CXXXVII)

Inkjetting Conductors

Karl H. Dietz (for CircuiTree Magazine, February, 2007)

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The EIPC Summer Conference in Venice, Italy, June 2006, featured a session on the impact inkjetting will have on the traditional ways of building PWBs. The general consensus seemed to be that indeed there is an impact and it is real, but it depends on the application and PWB type. Inkjetting legend print is definitely a reality [Ref. 1], inkjetting etch resist is coming along, inkjetting soldermask was demonstrated by Schmid at Productronica 2005, but inkjetting conductors or semiconductors seems more distant. Well, maybe not. The following is a random collection of indicators that suggest that conductor printing is gaining momentum.

On November 1, 2004, Seiko Epson Corp. announced that it had built a 20-layer, 0.008-in thick PCB—the highest layer-count multilayer ever built using inkjet technology. Epson's process uses an inkjet engine to alternately "draw" patterns and form layers on the board using two types of ink: a conductive type containing silver particles—some just nanometers in diameter—and a newly developed insulator ink.

Mike Johnson of Conductive Inkjet Technology reported at the EIPC 2006 Summer Conference on a reel-to-reel production line using inkjet deposition of a catalytic base layer, followed by metal pattern build-up with an electroless plating process to form flexible circuits.

Donald Hayes, MicroFab Technologies Inc., reported that metal nanoparticle inks are being developed to print conductors and electrodes for a wide range of electronic and energy storage applications [Ref. 2].

Cabot Printable Electronics and Displays (Cabot PEDs), a business of Cabot Corp. signed a distribution agreement with Digital Graphics Inc. (DGI), developer of the world's first Industrial Roll-to-Roll Electronics Inkjet Printer.

Cabot's Inkjet Printable Silver Conductor Products allow for digital printing of metallic conductive features on a variety of substrates. In addition, these products offer reliable inkjet printing on piezoelectric multi-nozzle inkjet printheads, low temperature post-processing, short tact time,

	Parmod® Silver	Parmod® Copper	Etched Copper	PTF	Thick Film
Process Type	Additive	Additive	Substrative	Additive	Additive
Cure Temp. ^oC	135	300	N/A	150	650
Resistivity m-ohms/sq/mil	2	2.8	0.7	20-30	2
Substrate Solderability	Yes	Yes	Yes	No	Yes
Wet Processing Waste	No	No	Yes	No	No

Figure 1. Parlec's Parmod® VLT inks and pastes (source: www.parelec.com).

good adhesion, and low resistivity.

Parelec [Ref. 3] offers a line of conductive inks and pastes (Figure 1). The inks can be inkjetted onto dielectric substrates and cured at relatively low temperatures to form circuit patterns. Other patterning methods include screen-printing, laser "mill and fill," and computer-controlled microdispensing.

While considerable attention is given to inkjetting in electronics, one should not overlook the larger field of printable electronics that employs other methods for printing conductive patterns. PolyIC, for example, uses a technology that is based on electrically conducting or semi-conducting polymers which are printed on flexible polyester substrates. The conductive polymers may be applied by flexo-printing, offset printing, or rotary screen printing.

There are new mass markets for low-cost, thin, and flexible electronics that can be easily integrated into packages or other substrates because of their design on flexible polyester substrates. Therefore, polymer electronics are no direct competitor to conventional electronics, but rather open up new markets in price-sensitive mass applications.

The main areas of application for printed electronics are:

- RFID (radio frequency identification) tags for contact-less identification of products
- Displays as simple optical indicators combined with further printed components
- Smart objects as combined systems of different polymer electronics components

References

1 Fine Lines in High Yields, (Part LXXIII): Ink-Jet Applications in Electronics, Karl H. Dietz, *CircuiTree*, October 2001, pg. 62.

2 Printed Electronics Utilizing Inkjet Technology, Donald Hayes, MicroFab Technologies, Inc., The Twelfth Meeting of the Symposium on Polymers for Microelectronics, May 3,4, & 5, 2006, Winterthur Museums & Gardens, Copeland Lecture Hall, Wilmington, DE.

3 Parelec, Crescent Avenue, Building C2, P.O. Box 236, Rocky Hill, NJ 08553-0236 (www.parelec.com).

4 PolyIC GmbH & Co. KG, Tucherstrasse 2, 90763 Fuerth, Germany (www.polyic.com).

5. www.printronics.de