Thinking about printed electronics? It is all about functionality

Tony Donato, product development engineer at Harper Corporation of America, explains the world of printed electronics and functionality

Inks and substrates must be compatible. Daily environment required for the device. That calculation will determine the criteria for what size printed trace line (cross sectional area) is needed. To complicate production planning, material costs are also considered in determining how to print. With silver at the higher end of ink costs, even though the amount carbon ink needed may be two or three times more, carbon ink may be the preferred choice and require using different anilox rolls than initially specified.

Think of extension cords. They come in different wire gage sizes and number of strands; the combination determines how much current can flow without damaging (melting) the cord. If the wire size is not sufficient for the required current flow, heat will be created. As many have learned the hard way, an extension cord sized to light a lamp is not the proper conductor for an air compressor, even if both rated for the same voltage. The good thing about R2R printed electronics is that circuits or devices typically are designed for low DC voltages and current (except in Electroluminescent (EL), where an AC electric field is required).

From the printer perspective all materials used must fit together and function in the daily environment required for the device. Inks and substrates must be compatible.
Even the moisture content of a paper substrate needs to be considered because it could affect the performance of a printed device. Also with many inks, elevated drying temperatures may be needed to sinter (sintering can be thought of as a curing method for the ink) the metal particles of the ink into a continuous trace line. These elevated temperatures can damage conventional PET substrates and other plastics. I have curled and wrapped paper and ruffled PET trying to sinter the ink.

Not all functional printing entails conductive inks. For example, biomedical applications can be achieved with printing too. For example, sensors may be printed that absorb sweat so a chemical reaction may take place to detect a predictable physical outcome. These sensors can be used for monitoring a health factor.

In summary, the mindset needed to print PE or other functional devices needs to grasp all aspects of the printed job, not merely its appearance. The materials used will need to have functional properties. The functional properties will need to be tested using a multifunction electrical meter or test fixture and not a spectrophotometer. To fully cure the ink and not damage the substrate sintering methods will have to be investigated that are not on the average flexo press. PE is not simply putting conductive ink in a print station. There is a lot to consider.

From the contacts I have met over the years in exploring PE, I landed on an electronic geek website, Sparkfun, which has a Bare Conductive ‘Touch Board’ to ‘turn touch into sound’. So a project was started to use the ‘Touch Board’ to create a hybrid device that used a flexo printed component combined with conventional microcontroller development platform. Hybrid devices are a realistic approach using conventional electronics that cannot be Flexo printed as the brains of the device. Flexo print can be used to build the traces as well as print the capacitive sensing ‘touch pad’. The ‘Touch Board’ can accept 12 inputs, so a conductive keyboard was laid out mathematically to match the locations of the inputs on the board and match the repeat of the plate cylinder of the Harper QD Flat Bed flexo print. Then a fixture had to be designed to couple the ‘Touch Board’ to the printed sensor touch pad.

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The 'Touch Board' has 12 sound outputs that are MP3 formatted so different sounds can be loaded such that when the printed sensor is touched the preloaded sound is produced. One other neat feature of the board is the sensitivity of the capacitive sensor can be changed to make the board be a proximity sensor (1") instead of merely a touch sensor.

The following picture shows all the components.

The QD Flatbed Flexo Printer was used to print conductive carbon inks for testing of trace line conductivity for touch sensor patterns. Testing different plate images and anilox engravings (120/15 XLT, 75/29 XOS and a 200/14.0 XOS) is easily done to find the best combination to work with a Touch Board combined with a print mounting fixture to demonstrate direct contact and proximity contact in a hybrid device with MP3 added sounds and a printed sensor pad.

In the picture on the left you can see an amber LED light illuminates (top of photo) when a key is touched and on the right picture the proximity of a hand activates the board. We made a video that shows the printing of the project and the project in action: https://www.youtube.com/watch?v=a8bgXCTBdlo.

If I had to guess, only around 1 to 2 percent of flexo printers are doing a form of functional printing today, but those numbers will keep expanding as flexible and wearable device applications gain popularity. Perhaps you will be one of the leaders in functional printing.

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