THE EVOLUTION OF THROUGH-HOLE SCREEN-PRINTING

Mike Bacon unfolds the advantages of vias when working with conductive inks

When a manufacturer of printing equipment develops a new technology that meets a specific customer application there is a short-lived congratulatory moment that follows. These moments can be celebrated through awards and publicity, but the key for the equipment manufacturer is taking this technology and finding mass appeal so that a product line can be developed. For niche markets, the appeal falls into a smaller pool of users but, within this circle, the technology is priceless.

Equipment manufacturing technology is typically born from a fundamental problem that is identified with an existing technology. This is followed by a person or group of people that are familiar with the existing technology and have the ability to make the technology better. Sometimes the break-throughs are significant, like the light bulb or the Internet, while other times they are simply enhancements to an existing technology such as the iPhone 6 or a new version of an automobile. Nonetheless, it is innovation that drives technology.

As manufacturers of printing equipment, companies continue to develop technology that will provide a better product at a cheaper price, reduce the number of rejects from a given process and create greater efficiencies within a given process.

Over the past few years, printed electronics suppliers have turned their attention to reducing the manual intervention required for producing through-hole printed flexible circuits on pre-cut material. The pre-cut holes are called vias.

VIA HOLE PRINTING

Vias are small holes that allow conductive inks to pass through the top surface of the substrate to the under surface. This provides for electrical connections between the conductive patterns on both sides of the base material. Via hole printing was developed to take advantage of both sides of the substrate for extremely intricate and densely populated circuit designs.

Due to an increase in the complexity and demand of modern flexible circuits, screen-printing equipment manufacturers have been asked to develop better ways to achieve through-hole printing that moves away from traditional sheet-fed screen-printing. Previously, through-hole printing was designed to print conductive ink on pre-cut sheets of material with a filter paper sheet that required manual insertion and removal by the operator.

During high-volume runs, ink build-up can be transferred to the screen-printing bed and require the operator to clean the bed every time a sheet is removed. While the filter paper is necessary to keep conductive inks printed through via holes from remaining on the screen-printing bed and ending up on the next sheet placed in the screen-printing station, there had to be a better way to screen-print flexible circuits.

AUTOMATING THE PROCESS

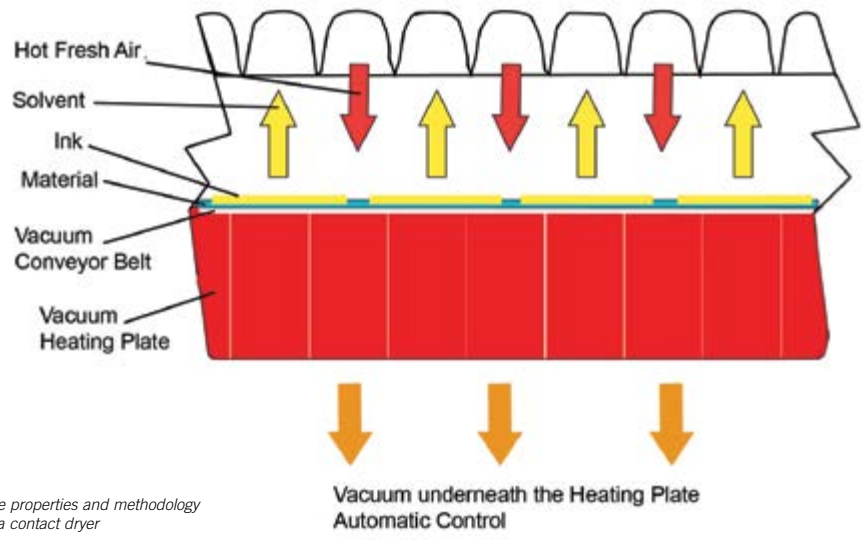
How could this process be automated? The most efficient way was to offer a roll-to-roll flat-bed screen-printing machine with a roll of filter material that moves along with the printed material. This filter material unwinds and rewinds through the screen-printing zone and dries before it reaches the rewinding roller. The filter material can then be re-used on another job, further reducing costs to the supplier.

How does roll-to-roll via hole printing work? The optimised thickness and structure of the roll of filter material increases the quality of the through-hole print by greatly reducing the smearing of inks from the vias on the opposite side of the material. This greatly reduces the number of rejects for a given job run. Flat-bed printing equipment that offers roll-to-roll filter options incorporate a vacuum table surface that holds the material in position during the printing process. The stronger the vacuum pressure, the better the material is held in position.

Pre-cut material requires specific control of the vacuum intensity to hold the material in position and help to transfer the ink through the via holes. Roll-to-roll systems also include an electronic vacuum sensor that measures the amount of suction on the printing table and adjusts the vacuum pump automatically. This ensures that the vacuum suction is the same no matter how many holes are in the pre-cut material.

The accuracy of the printing process also depends on the material stabilisation. The main material substrate and filter material are transported using the same servo driven system which provides even greater accuracy for the via hole printing. The overall tolerance on most systems is +/- 0.004 inch.

Another advancement of roll-to-roll screen-printing via hole printing is the increased efficiency of drying conductive inks. Most ink manufacturers will tell you that inks can be made to dry quicker by using a faster evaporating solvent system. The upside to this method is that the inks dry faster in the dryer. However, the downside is that the inks also dry faster on the screen which creates ink build-up on the screen.



The properties and methodology of a contact dryer

DRYING SYSTEM EFFICIENCY

Traditional systems use a hot air dryer system that blows hot air across the top of the printed substrate. This process is effective and is utilised in many screen-printing systems; however, advancements in contact dryers help customers dry conductive inks up to 70% more efficiently. The main advantage of a contact dryer is that the drying element is underneath the substrate therefore evaporating the solvent from the bottom to the top. For example, if you turn on a normal baking oven at 65 degrees C (150 degrees F) and put your hand in contact with the heating elements, you will get burned immediately. If you put your hand in the oven without touching the heating elements, you can leave your hand in the oven for a longer period of time without getting burned. Hot-air drying versus contact drying is the same idea.

When using a contact dryer, the printed substrate runs over a vacuum plate system that dries the ink from the bottom and does not allow the hot air to escape. Traditional air drying systems blow hot air across the top of the printed circuit and can be subject to what is known as 'skin effect' or drying on the top and not all the way through to the bottom. In general, more concentrated heat over a vacuum plate has shown to give the inks more conductive properties and increase the speed in which the inks dry.

REDUCING THE FOOTPRINT

The final advantage to the contact dryer is it reduces the overall footprint of the system design. Since the contact dryer is more efficient, the space required for the drying system can be reduced. When determining floor-space requirements for a screen-printing line, this advantage can make a great impact when positioning a system in an existing facility or planning for expansion or a new facility.

The technology for producing more efficient screen-printed via hole products has changed due to the co-operation between flexible circuit printers and equipment manufacturers – a specific problem with a specific solution. The advancements derived from packaging existing technology in a different way. The change from sheet-fed via hole printing to roll-to-roll printing technology tremendously reduces labour costs and part rejects. Furthermore, the ability to gain up to 70% efficiency in drying time and reduce the space required for the overall system design adds to the overall technology driven solution.

Can the solution be compared to the significance of the original iPhone? No. Does it help in designing different and more powerful versions of the iPhone? Absolutely. ■

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