Manufacturing Differently With Digital Technology

Feature Interview by Marcy LaRont
I-CONNECT007

As circuit board manufacturing companies and their equipment suppliers go, you don't see too many new ones, but groundbreaking technology is a different story. Founded in 2012 and based in Schwetzingen, Germany, Notion Systems is an industry leader in additive manufacturing technology of functional materials and inkjet printing equipment. Their tagline, "The future of additive manufacturing," was demonstrated when I spoke with Antonio Schmidt, senior vice president of sales and marketing, and David Hahn, vice president of process R&D.

Case in point, I had never heard the term electrohydrodynamic (EHD) printing, which is a more advanced additive inkjet technology that can be used in microfabrication for sub-micron resolution. We talked about how Notion is working to mainstream additive technology in the PCB and PCBA industries step by step, replacing current technology while they develop additive technologies.

Marcy LaRont: Notion was founded in 2012 and would be considered a "new" company in this industry.

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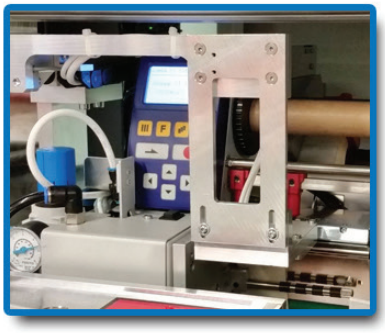

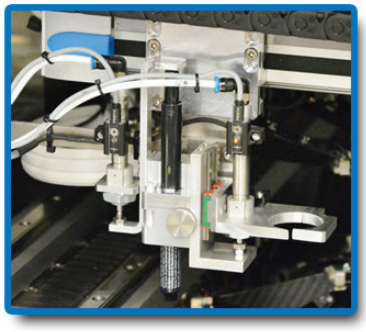

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Antonio Schmidt

Antonio Schmidt: Yes, but the core Notion team has made inkjet systems for decades when we were part of a company that designed and built equipment for the solar industry. For the past two years, we have been part of the German-based Lab 14 group.

What is Notion's DNA—your special sauce, if you will?

Schmidt: We design and build all systems on our own, and we wrote the software core for all inkjet systems. We have a huge application know-how, and all our machines have very high stability and repeatability. We are active in many industries, PCB fabrication being one of them. Our main markets are the display industry, where we print color filters of OLED displays; the electronics industry, where we print sensors; and the semiconductor market, where we are active in several new applications. The semiconductor market, especially, is picking up fast. In PCB manufacturing, we currently have 20 installed machines and we estimate our market share at approximately 50% worldwide. Inkjet technology offers tremendous benefits to replace traditional process technologies in all these industries and makes manufacturing more ecological and economical.

When we talk generally about inkjet technology, and inkjet solder mask specifically, you are removing several processes. That is key to greater adoption of this process in places like the U.S.

David Hahn: The number and type of processes that are eliminated with inkjet depends on how you manufacture the PCBs. Typically, you can remove several process steps, such as spray coating (which is a very dirty process), drying/curing, direct imaging, and the development process. You have no waste as you only print the solder mask where it is required. In addition, you are using a UV-based ink, which is cured right after printing. It is not required to use a solvent-based ink, which is hazardous to

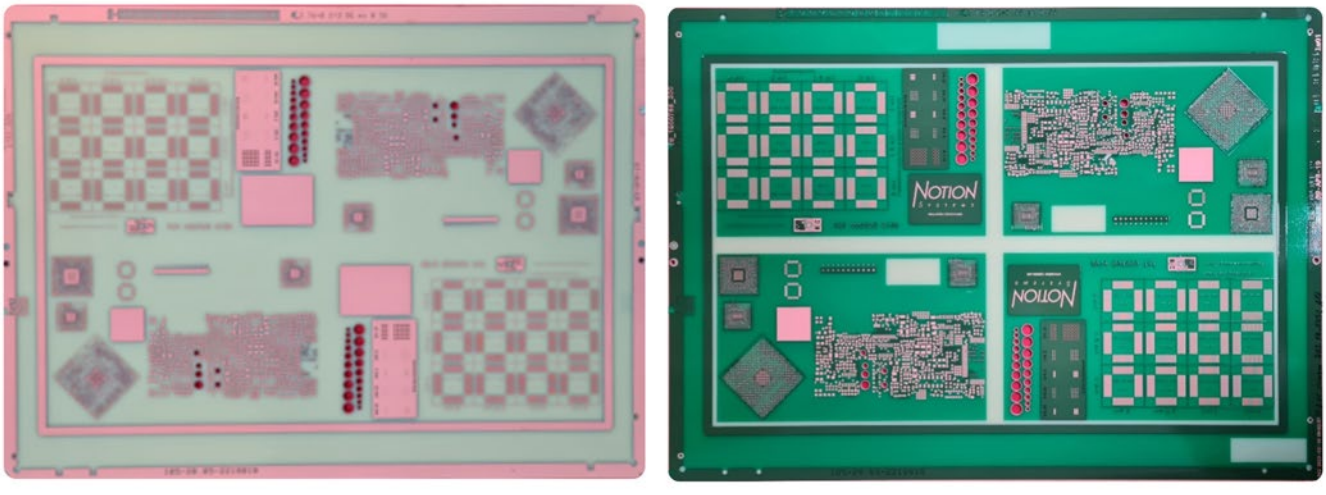

Figure 1: Examples of using inkjet printing.

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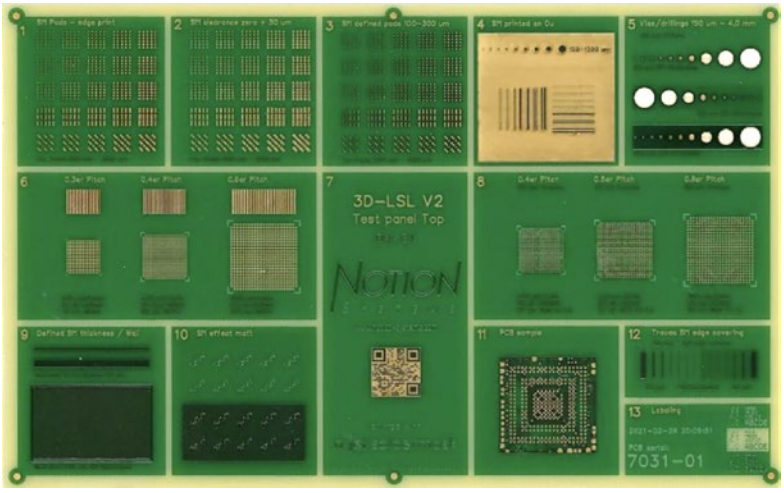

Figure 2: Notion's demo board explains all the possibilities in more detail.

health and smells bad. You also get rid of maintenance tasks because you do not have so many different machines that need to be maintained. This all translates directly to money saved.

What types of printing can your machine do inside one system?

Schmidt: Besides solder mask printing, we offer a legend option in our machines, so both solder mask and legend can be printed inside one machine. You are loading only one time to print both. Instead of legend, you could choose a second or third-color solder mask. You can print 3D structures and walls and print a matte or glossy finish by simply changing the print strategy. We only print where we need the ink, but we also print as much as we want. You can use the same machine with additional printouts and the additional check system.

Hahn: One of the most significant benefits is that you have good control over thickness in areas where it is a consideration. We conducted a study where the thickness was 50 microns in one area of the board and 100 microns in another area. If you have a small area of the PCB where you have very high currents, you can fill that, or you can cover it with a greater thickness very locally. In a more conventional inkjet process, you would need to go very slowly over that area many times to get the desired thickness. But with this process, you can do it in one go, based on how you program the machine. This is very fast. You print only where you need to.

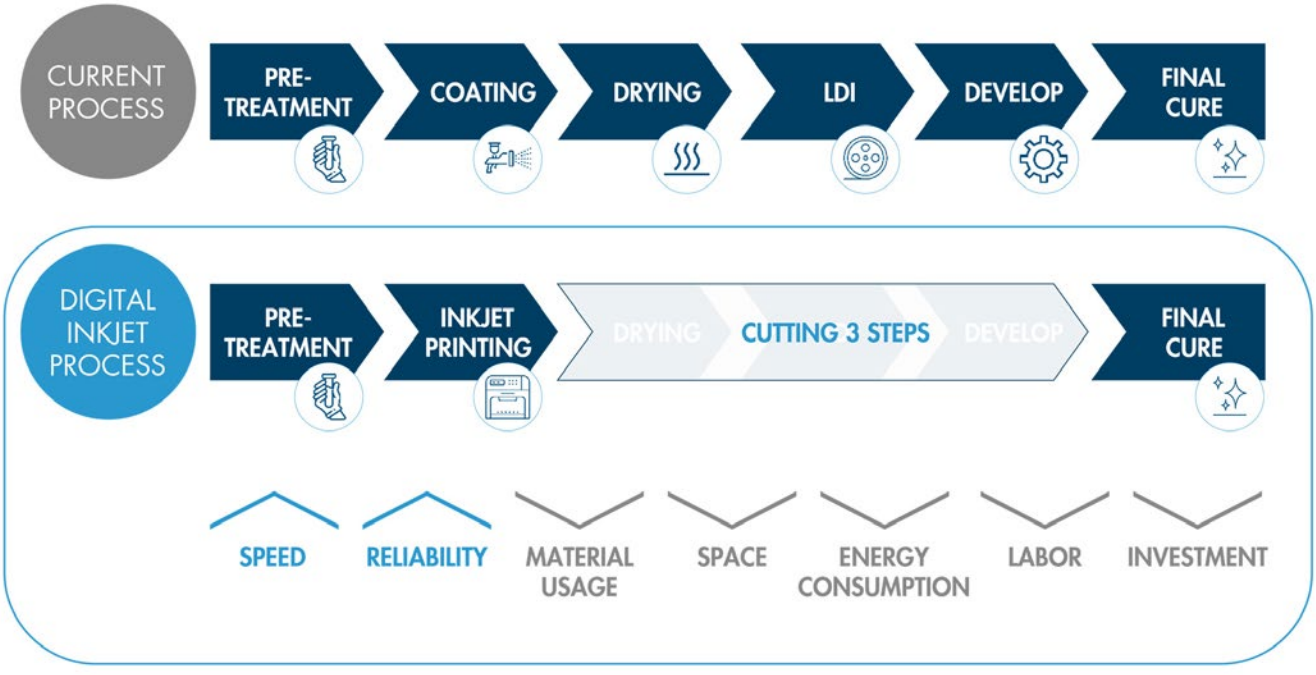

Figure 3: A breakdown of the digital inkjet process.

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Is the quality and reliability of the product better or equivalent to the traditional, standard process?

Schmidt: It meets all IPC specifications, so it is equivalent, but it allows you to add features that you could not with the traditional subtractive process, and it is a much more ecological and economical process.

There are a lot of benefits for manufacturers, but change is never easy. How do you make ROI more concrete?

Schmidt: ROI is tricky because much depends on the labor and energy costs. For instance, energy is expensive in Europe and cheap in China. Inkjet solder mask manufacturing is perfect for mass production. It is digital and can be fully automated, and several process steps can be interconnected. One operator can supervise several printing lines. Of the two systems in one, One is printing on the front side, the other on the rear side. Everything can be fully interconnected from pre-treatment through solder mask printing, final cure, and unloading into cassettes. Inside is a barcode scanner that scans the assembler code. Based on that, the machine knows to select a specific print program, and it just goes. On a traditional process line, you must have at least multiple operators to run the same process. That is probably one of its most significant benefits, especially with the workforce issues manufacturers see everywhere. It means better quality and reliability and far less labor.

Hahn: This machine needs a little bit more energy than your big fridge at home; an estimated 50% energy savings, and we would say roughly a buyer experiences a 75% savings on labor and reduces their occupied floor space by 50%. The process is zero waste and basically zero maintenance.

Give me more detail about the maintenance and calibration of the print heads.

Hahn: The machine itself does not need any operator interaction. The printing strategy gets put into the system by CAM and downloaded to the machine. The operator does not input any data. You can use different recipes, and it all happens automatically. Even the print head cleaning can be programmed periodically (typically one time per shift for <1 minute) in a fully integrated and automated cleaning station. All ink refill is done automatically by an external refill container station connected to the main tank of the system.

Schmidt: For quality control, the printer runs a nozzle pattern before the daily production starts. A camera inside the system checks whether all the nozzles are printing well and verifies if additional cleaning is necessary.

Figure 4: The machine set up at Schweitzer Engineering Laboratories' new facility in Idaho. (Source: SEL)

Has inkjet changed markedly over the past 10 years?

Schmidt: Yes, because we learn a lot with every installation and special customer requirements. There are also many more inks available than 10 years ago. Due to many Notion installations, PCB makers are creating more interest in this new technology. In a discussion with Ashley Steers at Electra during IPC APEX EXPO, all customers asked questions about the ink-

jet solder mask process, and no one asked about the conventional process.

Let's talk about workforce. You are reducing the need for people, which is a huge potential cost savings. This is a fully automated Smart machine. Do you need a process engineer to run the machine or just a trained operator?

Hahn: At least for your first machine, you need somebody who is interested in this new technology and is not reluctant to move to new technologies. We have developed several training courses. Our application guys go to the customer site for about two weeks to support the transition and work with the different teams: CAM, production, etc., and they support the customer.

What about advanced substrates vs. a traditional PCB? Inkjet printing seems to be the solution there.

Hahn: Advanced substrates are a fusion between the PCB and the semiconductor. It is very interesting. Right now, inkjet printing has some limitations because you cannot generate very, very small features. The limit is currently a 30 µm droplet and a 50 µm feature.

We are currently working on new printing methods such as the EHD (electrohydrodynamic) printing technology, which will allow printing resolutions around 1 µm.

Do you see Notion developing a greater focus on metal printing to take the place of traditional plating going forward?

Schmidt: This is one of our future developments, but we are not yet there. As far as metal printing, we are already working on a project on 3D-printed antennas for radar and LIDAR applications (TINKER project). In the first step, we print the basic 3D body of the sensor with a polymer, which is covered in a second step by a conductive ink and then sintered with a laser. As far as moving into new areas within an industry or market, we follow a measured, step-by-step approach.

David Hahn

Hahn: For the future, there might be potential for EMS companies that want to bring PCBs in-house, which would never make sense traditionally. With this technology, it might be a consideration because you do not need to focus on five different processes. There is just one machine that does not require all that floor space.

More education and training are needed. What do you feel is needed in the additive space to support engineers and technicians as we expand this technology for PCB manufacturers?

Hahn: I talked to IPC four years ago, trying to find somebody to help us form an additive class, but that also takes some time. It takes a lot of interest before there is movement whether on the level of company or industry. IPC has done a lot in the past few years. We hope to see that trend continue where additive process technology is concerned.

Thank you, gentlemen, for your time.

Schmidt: Thank you, Marcy. **PCB007**