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NOVACENTRIX

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NovaCentrix: An Award-Winning Force in PE Manufacturing

The company's PulseForge systems cure conductive inks at high speeds with light and little heat.

By Jack Kenny

PulseForge 3100

For an ink to work optimally on a substrate, it must meet many performance criteria. It has to flow properly from the press or the source onto the substrate. It has to maintain its integrity throughout the print job. It has to hold up in the drying process. Ink performance is managed by ink manufacturers through the introduction of various chemistries to the mix that control and enhance that performance. The result should be an ink of uniform thickness, appropriate density and relative durability.

In printed electronics, however, ink doesn't exist for the same reason as it does in the graphics business. Inks for graphics are supposed to look right, but inks for printed electronics have an entirely different job to execute. These are conductive inks, and good looks is secondary to conductivity. Still, conductive inks must have components in them that allow them to perform, ingredients such as stabilizers and surfactants that are present in ink dispersions.

The presence of those compounds, says Stan Farnsworth of NovaCentrix, represents "one of the fundamental conflicts with conductive inks – the need to have ink that is stable and printable, with good adhesion, but that also has to conduct. All of the things that go into ink to make it perform well inhibit the conductive function. That is the standard conflict with all conductive inks."

NovaCentrix, a 10-year-old company based in Austin, TX, USA, has developed what it says is a solution to that conflict. It's called the PulseForge family of tools, which anneal or sinter (to cause to become a coherent mass by heating without melting) conductive inks in milliseconds. The significance of the PulseForge concept was not lost on the producers of the IDTechEx Printed Electronics USA Show in San Jose, CA, this past December. NovaCentrix was named the recipient of the organization's Technical Development Manufacturing Award. "The PulseForge tools are a significant step in allowing printed electronics to be manufactured at commercial scale and cost, overcoming many limitations," wrote the judges.

Removing unwanted ink components

The PulseForge system possesses the capability of removing the unwanted components from conductive inks in an extremely fast drying process. "After an ink or material has been deposited – whether by printing, vapor deposition, spin coating, or drawdown – the first step is that typically the tools can dry the inks, so they can remove the solvents and the organic materials that go into an ink dispersion, the surfactants, stabilizers, etc.," says Farnsworth, vice president of marketing for NovaCentrix.

"If you are printing on glass or metal, you can put the product in an oven and cook things away. For example, in solar cell printing, the materials can be fired in an oven at a temperature that drives away all of the ethylene glycol and other components in the ink. That allows the metal particles to get good contact with one another."

If a manufacturer is trying to make a printed electronic circuit on paper, or on polyethylene or polystyrene, Farnsworth says, those substrates will not survive a high processing temperature. "There is a historical need for high temperature processing but on low temperature materials," he notes.

Ink developers have made strides in trying to produce inks that have good performance on low temperature substrates, according to Farnsworth. "One problem is that some inks have stability issues; some traditional ink formulations require high temperatures to drive away the other components." One way around that issue is to employ screen printing, which deposits an extremely high volume of ink, thereby assuring good conductivity. But if the conductive material is silver, and it often is, the process could have an impact on the eventual cost of the item being produced.

The PulseForge is designed to dry conductive inks on low temperature substrates. "We can get performance on low temperature substrates that is comparable to ovens because of the speed of the process," says Farnsworth. The machine performs its task in a matter of milliseconds. "The ink temperature will go from room temperature to hundreds of degrees and back to room temperature again in milliseconds," he adds. "That thermal cycle is high enough to drive away the organics, but short enough to have no impact on the substrate."

A web running through the PulseForge 3100, the production model introduced in 2008, can reach 100 meters per minute (328 feet per minute), depending on material and exposure conditions. "We designed it specifically to have the kinds of speeds that our markets are using. It wasn't a trivial process – it took altogether more than a year of development to get to that point," Farnsworth says.

High power, low energy

Specifically, the PulseForge heats inks "by delivering a lot of power, so that the inks absorb the light that is emitted from the lamp assembly, and converts it into temperature," says Farnsworth. "But not a lot of energy. The whole point of the system is not a steady state, only the inks are heated to those temperatures. It's a transient heat transfer situation." The inks are thin and don't store a lot of energy, he adds.

At the heart of the system are high intensity strobes, driven by high powered pulse electronics technology that the company says is unlike anything on the market today. The strobes deliver energy to the target surface, selectively heating and fusing ink particles, and forming highly conductive pathways. The photonic curing process specifically targets inks and thin-film depositions, functionalizing them without heating or damaging the substrates on which they are printed, or affecting nearby thermally sensitive components.

"The whole system is designed to deliver energy in short bursts, less than 50 microseconds. It's shockingly fast," Farnsworth says. "It works because it's so quick, and if you flash once every second, you have a duty cycle of .05 percent. That's pretty low. That's how we are able to get a lot of processing speed, with lots of downtime between pulses. That's been part of the engineering."

NovaCentrix was launched in 1999 as a nanotechnologies company, and its first name was Nanotechnologies. The company was commercializing technology in making nano powders, such as oxides, nitrides and metals. "These are typically spherical or crystalline in shape, solid forms – not platelets, tubes, fibers or shells. We could get very accurate control of particle size below 10 nanometers and up to 100 nanometers," says Farnsworth, who has been with the company since its launch.

A few years ago the company decided to refocus its efforts on three markets that it had been supplying and develop products just for those: printed electronics, antimicrobial, and defense. "We worked on those three in parallel, which was exciting but tough for 25 people," Farnsworth recalls. After a year, however, the company sharpened its focus even further to devote itself to printed electronics.

"Three to six years ago, when customers were taking orders for nanopowders, we developed capabilities to make dispersions," he says. "Now we have some electroconductive inks. So we make materials, we make electroconductive inks, we buy materials from others. We don't make printers. We have some printing capability, and are in the process of growing it, but we are not a print shop at this time.

But NovaCentrix does make the PulseForge, and it is about to launch a more muscular sibling of the 3100, to be called the 3300. "It is designed for two types of applications: very high speed processing, at 1,000 feet per minute, for the packaging folks; but its primary design intent is to work with semiconductor materials. This is really annealing thin film semiconductor materials that have been deposited in an amorphous structure that we can crystallize. And also to process nanoparticles."

NovaCentrix was founded in 1999 as Nanotechnologies Inc., by Dennis Wilson, a member of the mechanical engineering faculty at the University of Texas. Today the company is headed by Charles Munson. Kurt Schroder is the chief scientist and developer/patent co-holder of the initial PulseForge process.

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