FlexTech Trends

A Toolmakers Perspective

Enabling Printed Electronics Progress

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It's a challenge to design and build tools before the intended users know they need them, especially tools for building products that don't yet exist. The complication is that new product technologies can require new processing and manufacturing methods, but the new manufacturing methods can't be developed without the products that will need them, creating a classic "chicken and egg" problem. Nowhere is this truer than in Printed Electronics, the moniker used to loosely group printed technology verticals including displays, RFID, PV, logic, battery materials processing, and flexible circuits. These technology verticals in turn enable applications in energy generation and storage, smart packaging, inventory control, and many other applications yet-to-be developed by creative product marketers and engineers.

In spite of the seemingly disparate applications of these technology verticals, they have at least one trait in common. High temperature materials such as silver, copper, silicon, and graphene need to be processed on low temperature substrates like plastics and paper. Without a robust means of heating the functional materials to their required process temperatures, the performance of the applications will be significantly limited, the product unit costs will be too high versus the performance of the devices for broad adoption, and the potential value of the sector will remain unrealized. NovaCentrix is working to help solve this conundrum by developing and offering the PulseForge processing tools for printed electronics, and is specifically offering tools with the recognition that not all users will immediately be ready for the full capabilities of the tools. Yet, it is precisely the availability of the advanced process and production capabilities that NovaCentrix hopes will contribute towards successful technology and product launches, and ultimately in meeting the market potential of Printed Electronics.

The PulseForge 3300 is the latest tool from NovaCentrix specifically addressing Printed Electronics development and manufacturing, and builds on the technology and process experiences gained with the other PulseForge tools. The common trait to all of the PulseForge tools of course is the patented use of proprietary lamps used to heat the target materials and not the substrates. Beyond that basic shared characteristic, each tool in the PulseForge family is designed for a specific set of users.

- The PulseForge 1100 is ideal for very early-stage material and product concept developers, who require very flexible energy delivery conditions, but do not require volume production.
- The PulseForge 3100 is optimal for development, scale-up, and manufacturing of metallic ink-based systems or high-speed drying processes on low temperature flexible substrates.
- The new PulseForge 3300 is purpose-built for processing silicon inks and thin-films, photovoltaic materials, and battery materials including ceramics, as well as very-high-volume processing of metallic systems, at speeds up to 300 meters/minute.

The PulseForge tools have also recently shown to be capable of directly processing thin polymers that historically might have required dedicated UV processing, but can now be processed much more quickly and without collateral heating damage.

To satisfy the requirements of silicon processing on low temperature substrates, and for very-high-speed processing of metallic inks on low temperature substrates, the new PulseForge 3300 has several key features. Foremost, the tool delivers power in the extreme ranges required to process silicon in several forms, delivering pulse lengths as short as 30 microseconds, and with exposures surpassing 40 kW/cm^2 per pulse. Given the process area per pulse with a 150mm-width system, this equates to a shocking 5 megawatts (MW) of delivered energy per pulse. The combination of short pulse lengths and high delivery rates is essential for creating the required thermal state of the target material systems. By controlling factors such as pulse length and pulse power, the user can tailor the tool to achieve the desired material response.

In recognition that different users of the PulseForge 3300 will be at different points in their development processes, the tool is able to operate in three modes.

a. Static Mode: Delivery of pulses to a single placed sample without conveyor motion, useful for early material development.
b. Samples Mode: Delivery of pulses with a conveyor programmed to run the samples under the lamp housing and then return the samples to the start. This is useful for early material development, and for processing pre-production samples.
c. Production Mode: Running the tool in a full-forward configuration, as for pilot production or full volume production. In this mode, the full benefit of the ~1 kHz maximum pulse rate can be realized, resulting in very high material through-put. For this mode, the PulseForge 3300 is integrated directly with the customer's material handling system, be it roll-to-roll or conveyor-based.

The versatility of the PulseForge 3300 also means that the same tool can be used for progressive phases of a product development effort, from concept and feasibility all the way through pilot production and ultimately volume manufacturing. In designing the tool with this capability, NovaCentrix is minimizing the customer's uncertainty and risk that comes from scaling prototype products into full production- the same processing tool can be used.

From a toolmakers perspective, the continuing technology and product developments in Printed Electronics are truly compelling. What technologist doesn't get excited about the vision of printed solar cells charging printed batteries powering printed displays, placed on packages, clothing, or buildings, or used in transportation? We support many groups working in many different areas, and the innovation and creativity that we encounter on a daily basis is inspiring. Our challenge as a toolmaker is not just to support those efforts, but also to stay ahead of those efforts with the tool and process capabilities needed for our customers to be successful. That's how we'll solve this chicken-egg dilemma in Printed Electronics.

Stan Farnsworth is VP of Marketing at NovaCentrix and has been with the company since its inception in 1999. He is responsible for strategic and tactical marketing for all NovaCentrix products, including the company's PulseForge tools and Metalon inks. While at NovaCentrix Stan has led commercialization and business development for nanomaterials and nanomaterial-enabled products for markets including optical coatings, life sciences, defense, printed electronics. Previously, Stan held engineering, operations, and management positions at Intercorr International, a small Houston-based consulting company, and Applied Materials in both Austin and Santa Clara. He has an undergraduate degree in mechanical engineering from Rice University and a master's degree in heat transfer and fluid mechanics from the University of Texas Austin.

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