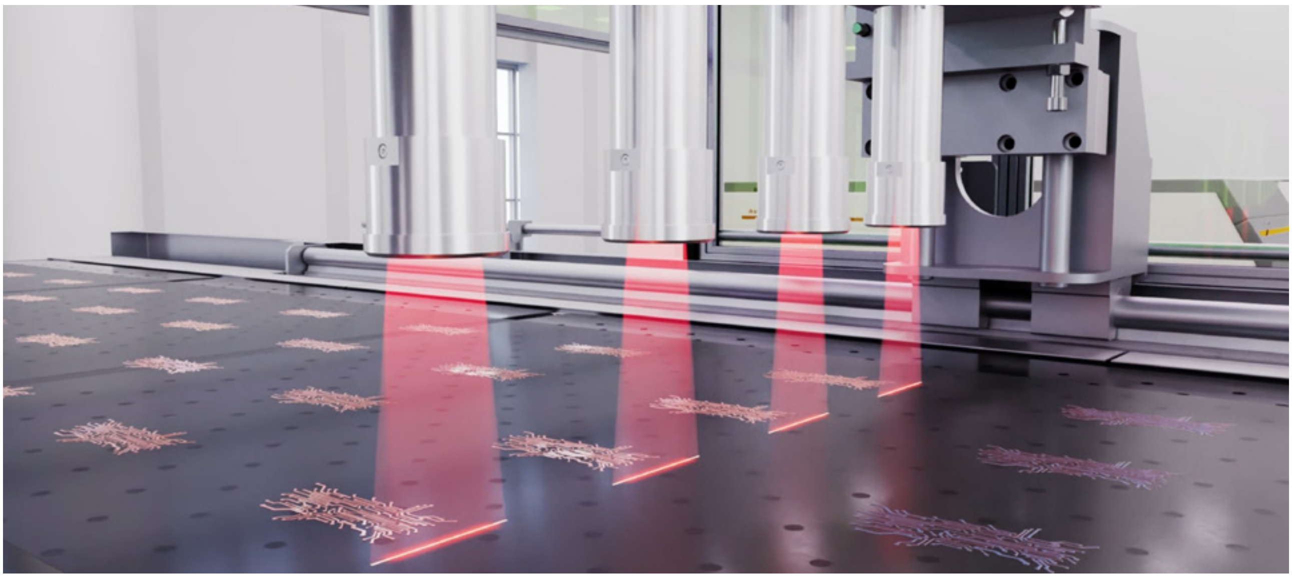
Laser Sintering, the Future of Printed Electronics

Laser sintering is a relatively new technology that uses lasers as efficient thermal energy sources, for sintering metal particle-based inks. Semiconductor-based near-infrared (NIR) lasers wield several advantages over traditional methods, such as hot air ovens and flash lamp ovens in sintering printed electronics.

Semiconductor lasers are highly energy-efficient and have long lifetimes that exceed 20,000 hours. They are also environmentally friendly. This is evident in their low energy consumption, minimal use of consumables, and reduced servicing requirements. These same factors also lead to considerable savings in operational costs and uptime for end users over the lifetime of the printing equipment. Laser sintering solutions have a smaller footprint than conventional ovens and can be easily scaled up in power for higher throughputs. NIR lasers are especially suitable for thermally sensitive substrates like polymers, which have miniscule NIR absorption compared to the inks. The same cannot be said for conventional ovens that also heat the print substrates to high temperatures. These and other advantages of laser sintering have often been discussed [1,2].



Artistic rendering of laser sintering in a R2R printing process.

Hamamatsu Photonics has been assisting the printed electronics industry to explore the potential of laser sintering to their advantage [3,4,5]. We have worked closely with several ink suppliers and printed electronics manufacturers to optimize laser sintering parameters in our application lab [5] and at our partner sites. Since laser sintering is a novel technology, its performance in real-world situations must be demonstrated with unbiased tests.

To achieve this, Hamamatsu's engineers partnered with researchers at Fraunhofer Institute for Electronic Nano Systems to create realistic high-volume printing conditions [6]. Specifically, the test conditions were set to simulate high-speed roll-to-roll (R2R) printing on an inkjet printer using silver nano-inks. The printing conditions were optimized for the inks used without considering the downstream sintering method, therefore laser sintering was not favored in these tests.

Both laser line illumination and scanning spot illumination were employed for sintering at printing speeds of 1.5-6.0 m/min. Remarkably, even with only a fraction of the laser power used, high conductivity of up to 2.22 × 107 S·m−1 was achieved in sintered products within a few seconds. This represents 36% of the bulk conductivity of silver, which is considered an excellent result in printed electronics. The results also indicate that laser line illumination is highly suitable for continuous printing, whether sheet-fed or R2R.

For more detailed information, we invite readers to access the peer-reviewed publication, which is freely available [6]. It is important to note that higher laser powers can potentially increase the throughput without any changes to the hardware footprint, making laser sintering a future-proof solution for end users.

Hamamatsu Photonics is keen to collaborate closely with the printed electronics community and support industry stakeholders in trialing laser sintering. Our application lab has tested different types of ink and accumulated broad experience to assist you in finding the optimal sintering conditions for various combinations of inks and substrates. In addition, highly customized laser sintering solutions are available due to the vertically integrated production facilities at Hamamatsu Photonics. So please do not hesitate to reach out to our team of experts at info@hamamatsu.eu for a discussion on how this could impact your business.

Overall, the promising results and ongoing development of laser sintering technology highlight its potential to revolutionize the printed electronics landscape, making it a critical area for future exploration and innovation.

References

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[6] Mitra, D.; Mitra, K.Y.; Buchecker, G.; Görk, A.; Mousto, M.; Franzl, T.; Zichner, R. Laser Sintering by Spot and Linear Optics for Inkjet-Printed Thin-Film Conductive Silver Patterns with the Focus on Ink-Sets and Process Parameters. Polymers 2024, 16, 2896. https://doi.org/10.3390/polym16202896