Combustion-Assisted Photonic Sintering (CAPS) research shows new potential for the future of printed electronics

Overview

Northwestern University researchers have investigated the capabilities of Combustion-Assisted Photonic Sintering (CAPS) in printed electronics. Their report sheds new light on future possibilities of functionality and flexibility in a wide range of applications. The study's findings demonstrate that CAPS technology not only enables the production of highly conductive and mechanically robust structures, but also offers unprecedented possibilities for intricate designs and multi-material integration.

Leveraging advanced equipment developed by XENON, the researchers in this study have demonstrated the immense potential of printed liquid metal nanoparticle films. The team's findings show real potential for next-generation electronics, flexible circuits, wearable devices, and other emerging technologies.

Markets/Applications

- Electronics Manufacturing: Conductive traces, interconnects, and circuits on both flexible and rigid substrates for a faster and lower-cost method compared to traditional sintering techniques
- Wearable Electronics: Smart textiles, flexible sensors, and stretchable circuits to develop more comfortable and durable wearable devices
- Printed Electronics: Printing conductive elements, such as electrodes or antennas, on various substrates using liquid metal inks to improve the production of flexible displays, RFID tags, and printed sensors
- Energy Storage: Enhance the performance and efficiency of batteries and supercapacitors for developing high-performance and compact energy storage solutions

Highlights

- Compared to conventional sintering methods, CAPS offers faster sintering times, typically within milliseconds, reducing production cycle times and increasing manufacturing efficiency
- Enables high-quality sintering at room temperature, reducing the risk of damage to temperature-sensitive substrates
- Scalable for high-throughput roll-to-roll processing, making it compatible with industrial manufacturing techniques
- Precise control over the sintering process allows for the creation of intricate circuitry and structures, expanding the design possibilities for electronic devices
- Significantly enhances the electrical conductivity of printed liquid metal nanoparticle films for improved conductivity and stable electrical performance

"The power of Pulsed Light enhances the sintering process and unlocks new possibilities for printed electronics and other high-tech applications."

The information in this report was prepared by XENON and does not contain the complete research conducted by Wallace et al. A full version of the research paper is available at https://onlinelibrary.wiley.com/doi/abs/10.1002/admt.202101178

Summary of Research

Combustion-Assisted Photonic Sintering of Printed Liquid Metal Nanoparticle Films

Original research by Shay Goff Wallace, Nathan P. Bradshaw, Nicholas X. Williams, Justin H. Qian, Karl W. Putz, Christopher E. Tabor, and Mark C. Hersam

Objective: Investigate and demonstrate the efficacy of CAPS as a rapid and enhanced method for manufacturing high-performance electronic devices using printed liquid metal nanoparticle films.

Methodology: The liquid metal nanoparticle films were deposited on various substrates using a printing method, creating the desired patterns and structures. The films were then exposed to Pulsed Light emitted by XENON Corporation's S-2100 flash lamp with pulse energies of 1–7 J cm^{-2}. The flash lamp voltage was set at 3 kV and the pulse width was modulated from 0.3 to 2 ms to achieve the different pulse energies. Samples were held at a distance of 25 mm from the flash lamp while applying single pulses.

During the sintering process, the pulsed light rapidly heated the printed films, causing the nanoparticles to fuse together and form continuous conductive paths. The intense light energy triggered a localized combustion effect, efficiently sintering the nanoparticle films. The researchers carefully controlled the pulse duration and intensity to optimize the sintering process and achieve the desired electrical conductivity and mechanical stability.

To evaluate the effectiveness of the CAPS technique, the researchers conducted extensive characterization tests on the fabricated devices. They measured the electrical properties, such as resistivity and conductivity, and assessed the mechanical reliability and performance of the devices. The researchers compared the results with devices made using traditional sintering methods to highlight the advantages of CAPS technique.

Results and Conclusions: The researchers successfully demonstrated that the rapid and intense Pulsed Light generated by the XENON S-2100 system significantly enhanced the sintering process, resulting in improved electrical conductivity and mechanical stability of the printed films. Further, the study showed that the use of CAPS technique enabled the production of functional electronic devices with excellent performance characteristics, such as low resistivity and high electrical reliability. These findings highlight the potential of this technique for various applications in flexible electronics, wearable devices, and other emerging technologies that require fast and reliable production processes.

The Pulsed Light Experts

XENON Corporation
37 Upton Drive
Wilmington, MA 01887-1018
USA
Telephone 978-661-9033
Toll Free 800-936-6695 (U.S.A. only)
Fax 978-661-9055
Email info@xenoncorp.com
Web www.xenoncorp.com