

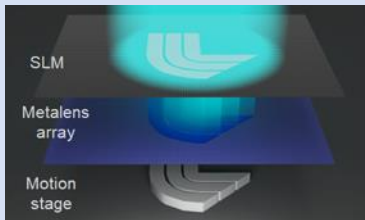
# METALENS-ENABLED TPP



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LLNL researchers are reshaping how complex nano-3D materials are TPP printed by leveraging a metalens array, which massively parallelizes the printing process.

Using a metalens array in combination with a SLM in a TPP AM system dramatically increases the printing speed while maintaining high print resolution.



LLNL has filed for patent protection of this technology (internal case Nos. IL-13643, IL-14010 and IL-14011).

U.S. Patent Application No. 2022/0252761 published 8/11/2022: [System and method for parallel two-photon lithography using a metalens array](#)

## Team



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## Challenge

Conventional two-photon polymerization (TPP) additive manufacturing (AM) printers have extremely slow printing speeds but are capable of fabricating micro- and nano-scale features.

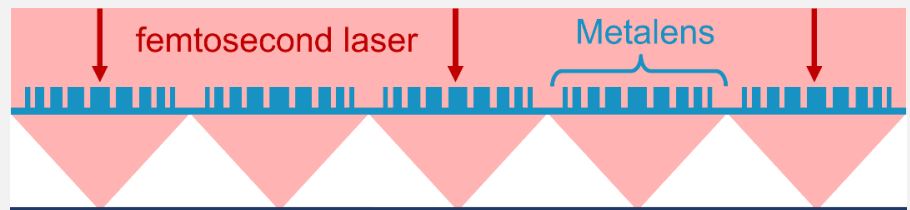
## Market/Opportunity

TPP is an emerging micro-additive manufacturing technique; the global market of TPP in 2023 is ~\$49M. Segments of this market require high-resolution, high throughput printing of complex, cm-scale components (e.g., micro-electronics and micro-optics).

## Solution

LLNL researchers have developed a customizable large metalens array, which in combination with spatial light modulators (SLMs), allows for high-volume fabrication of submicron-architected structures using TPP printing.

Whether the 3D printed objects contain periodic structures or arbitrary forms, the metalens array approach enables parallelization of the printing process, which significantly increases throughput of cm-scale components without sacrificing resolution or introducing stitching defects.



## Advantages

1. 1000X speed compared to currently available TPP printers
2. Wafer-scale components
3. 100nm-resolution
4. Free of stitching defects



## Applications

- Micro-electronics and Micro-electromechanical Systems
- Photonics and micro-optics
- On-demand 3D chip packaging solutions
- High-density 3D optical memory
- Architected metastructures
- Custom micro-heatsinks for the next-generation semiconductor
- Energy solutions
- Biomedical engineering

