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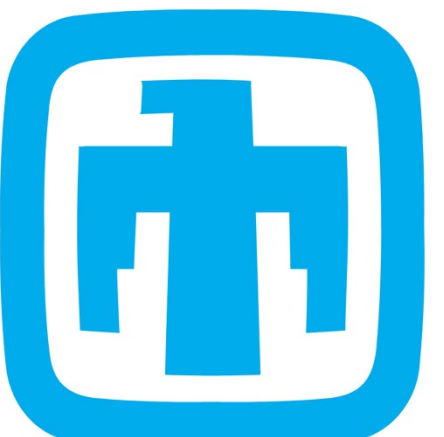
Large-Scale, Structured 3D Zinc Anodes for Zinc Batteries

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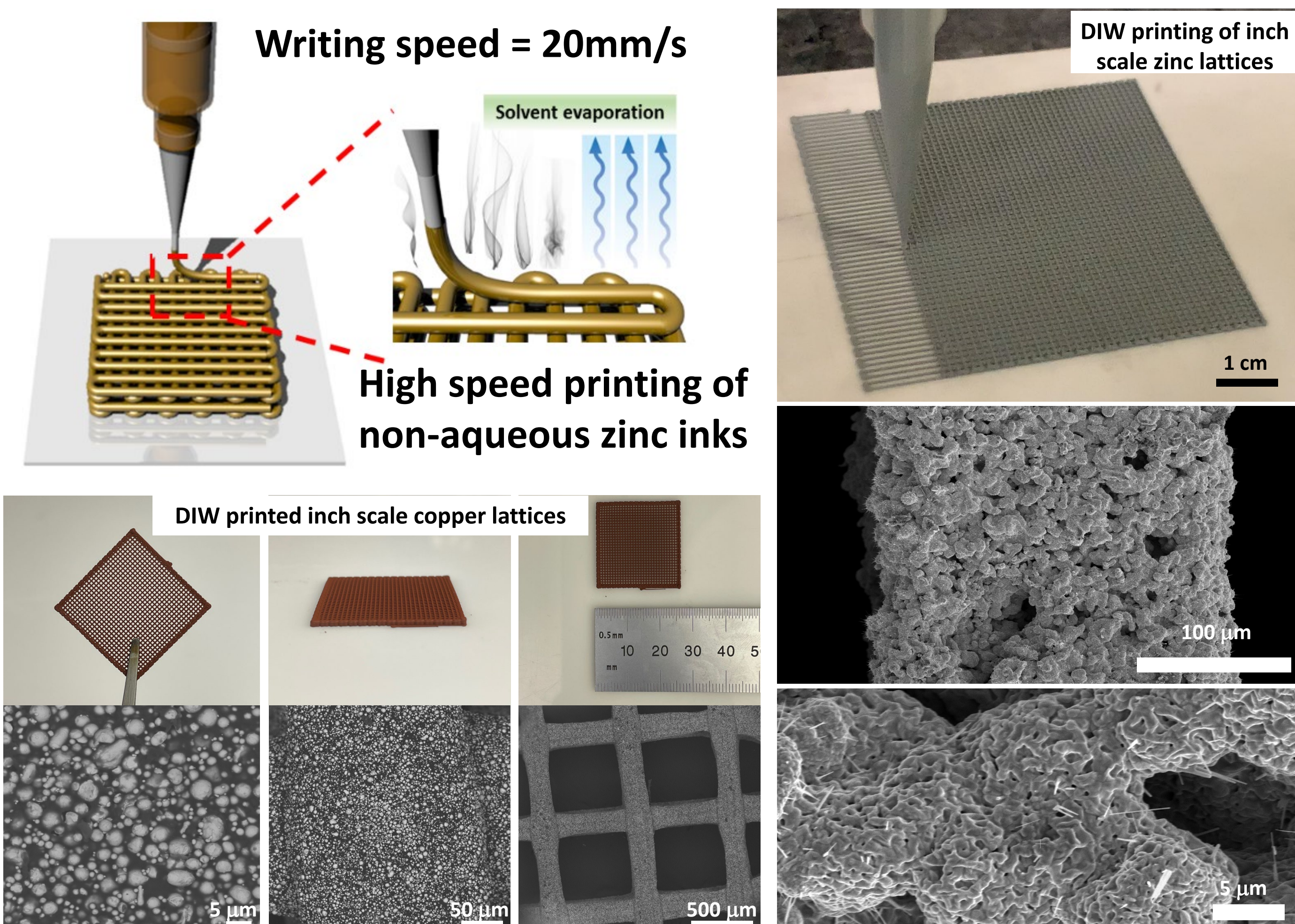


Sandia
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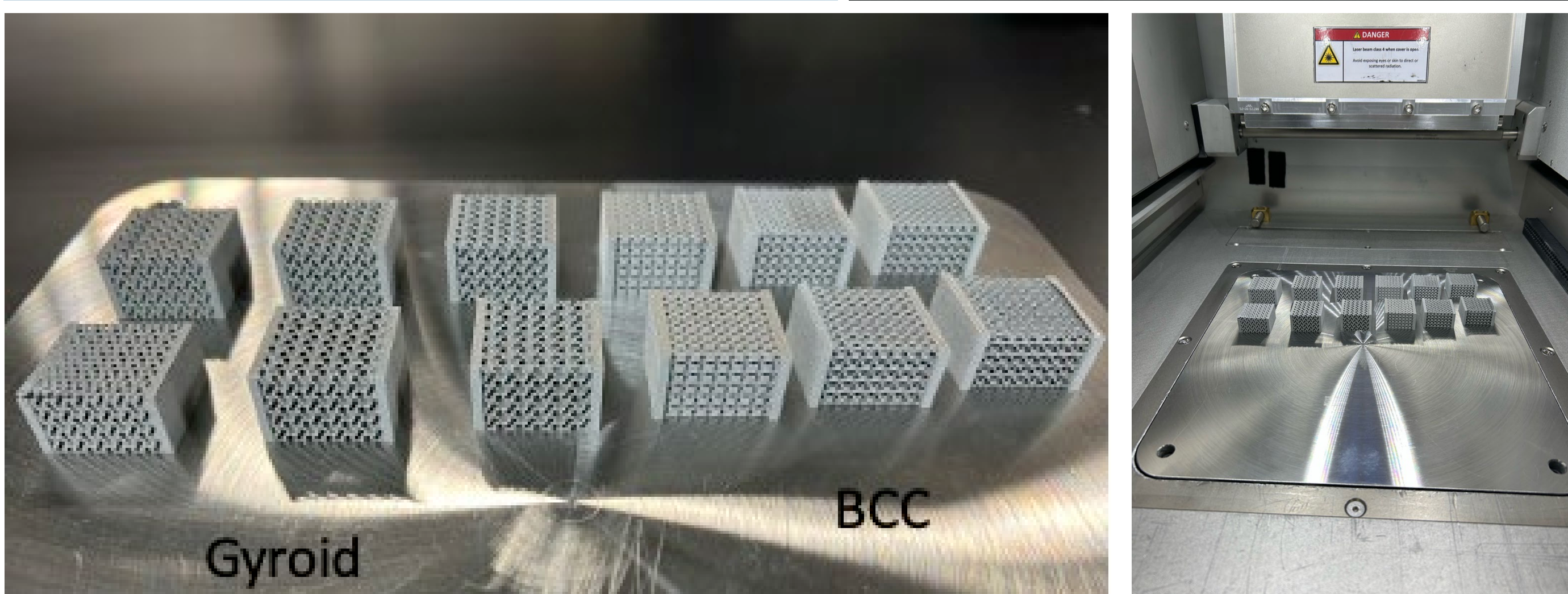
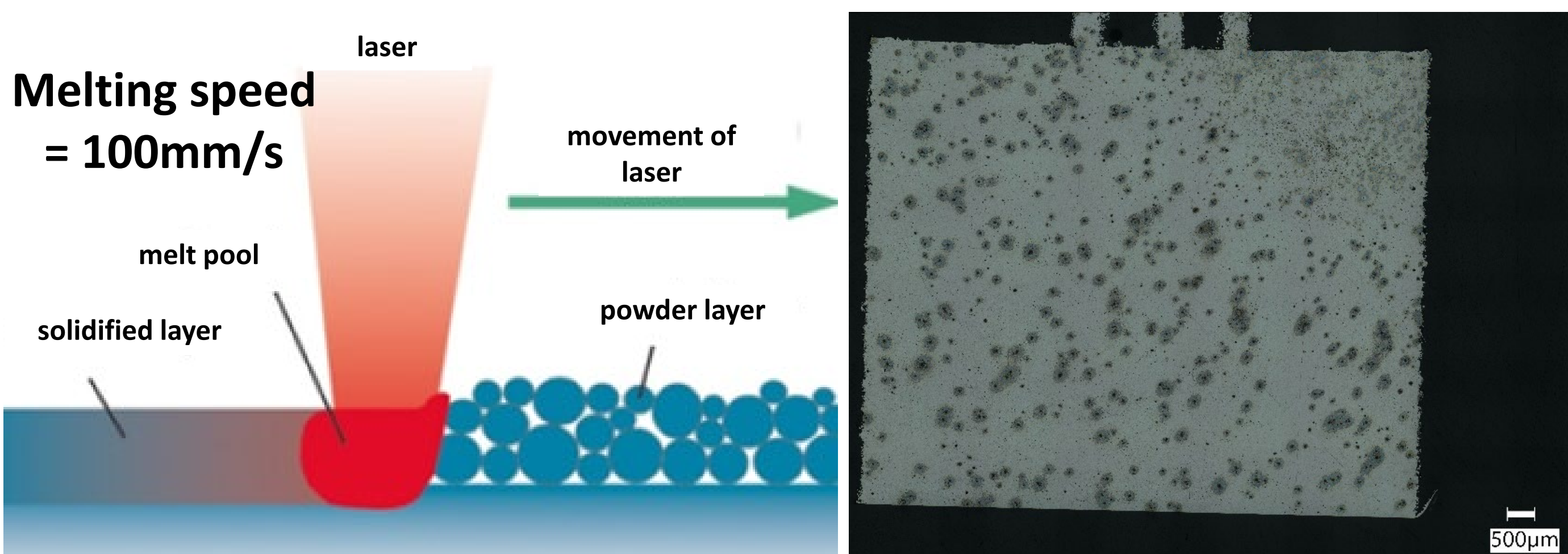
Project Overview

- Project Goal:** To demonstrate scalable manufacturing strategies for zinc batteries scale-up from coin cells to pouch cells.
- Current Practice:** Several advanced manufacturing methods have been used to create structured electrodes but still limited by their low efficiency and resultant high manufacturing costs.
- Why LLNL:** Our lab has unique expertise in scaling up of energy storage devices and has been collaborating with SNL for a few years, focusing on advanced manufacturing methods for Zn batteries.
- Innovation:** Extend current lab scale additive manufacturing approaches to large-scale, high-speed level to accommodate the future automated product line.
- Impact:** The successful development of scalable, structured zinc anodes will unlock low-cost, earth-abundant, and safe battery technologies that are well-suited for energy storage reliability and resilience applications
- Alignment:** This project contributes to OE's strategic focus on developing low-cost, and domestically sourced energy storage technologies that can enhance grid reliability and resilience.

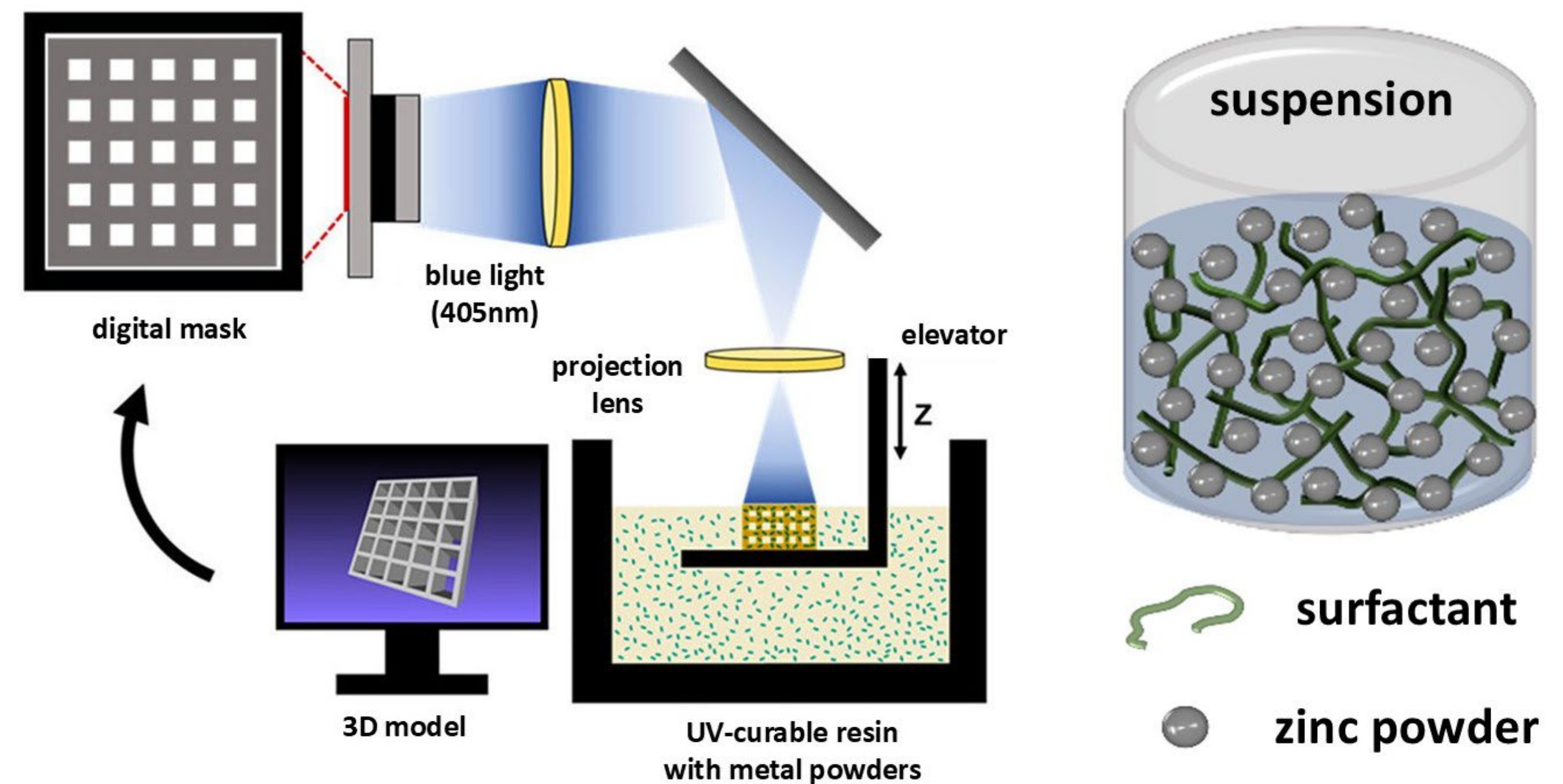
Scale-Up Printing via Direct Ink Writing



Scale-Up Printing via Laser Powder Bed Fusion



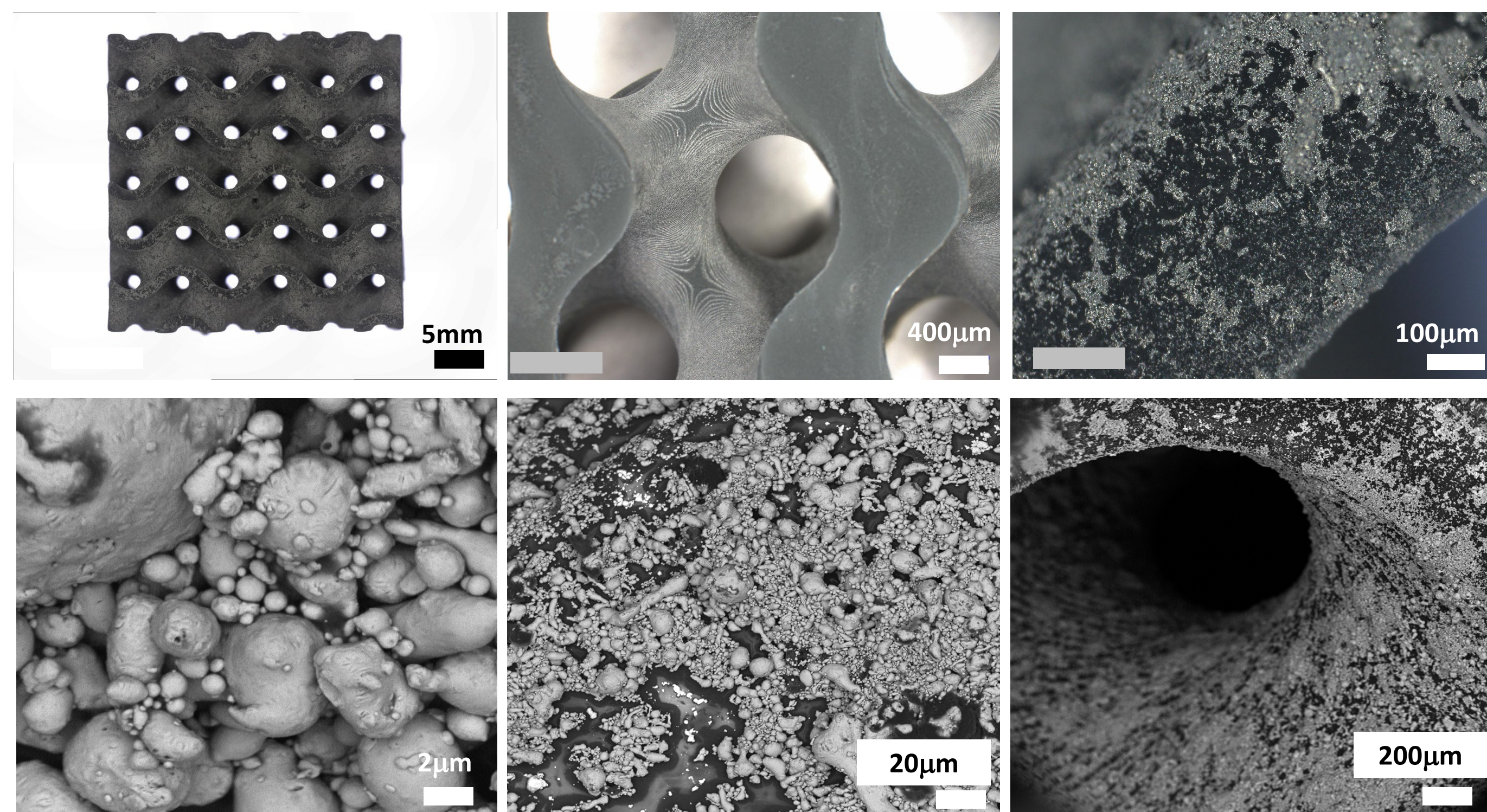
Scale-Up Printing via Digital Light Processing



DLP printed 10wt% Zn gyroid structure

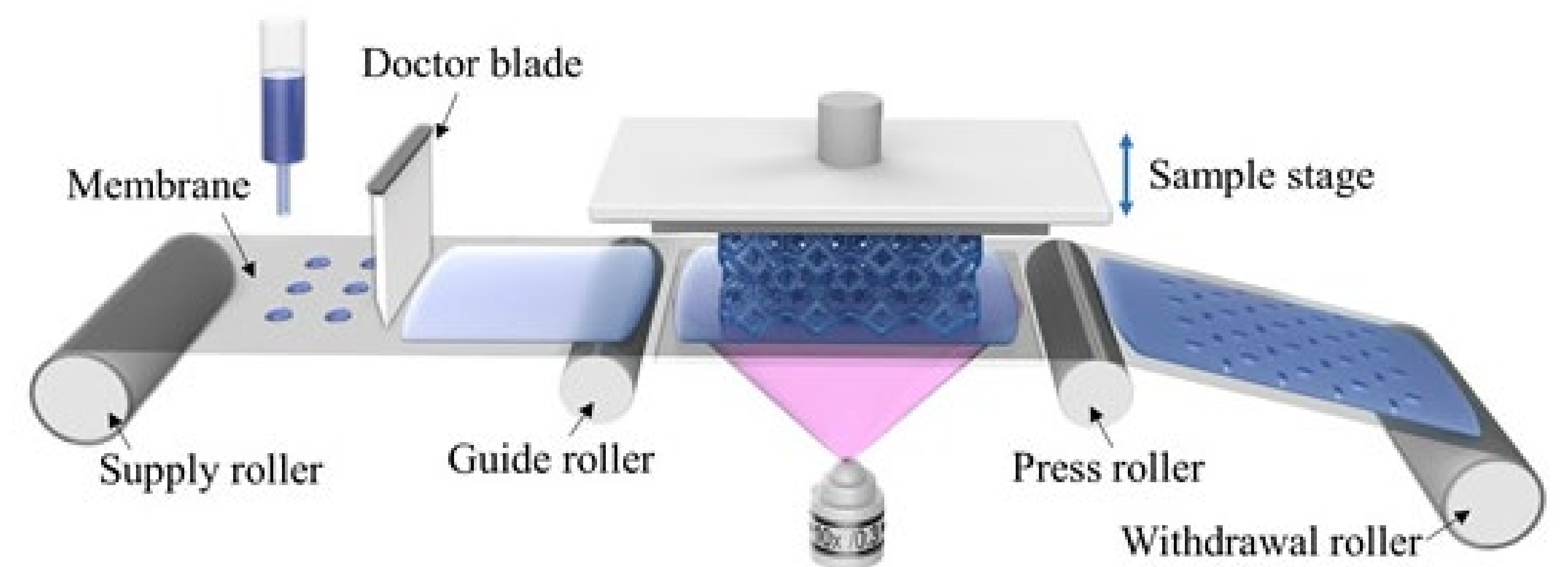


DLP printed 15wt% Zn gyroid structure



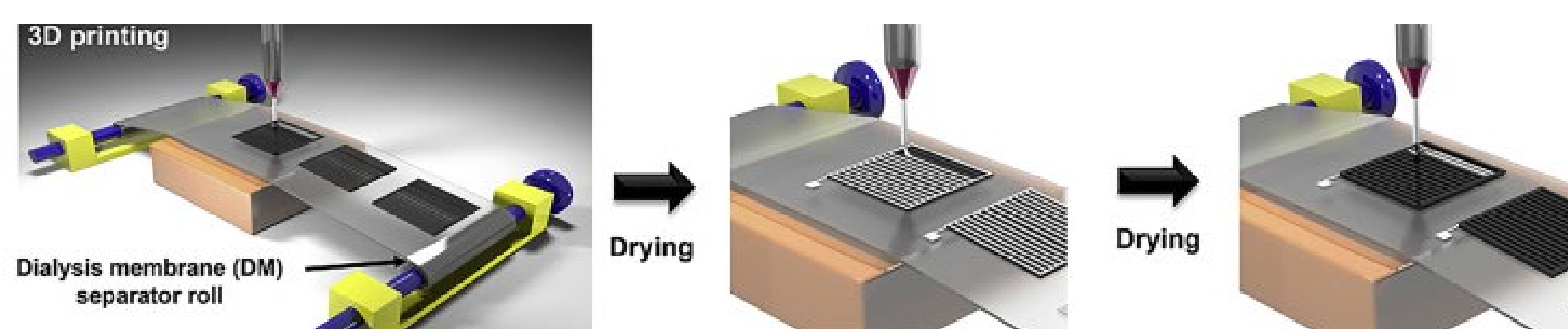
Integrating AM into Automatic Product Line

Digital light processing + roll-to-roll



Wu, Xiumei, et al. *Optics Express* 29.14 (2021): 21833-21843.

Direct ink writing + roll-to-roll



Ovhal, Manoj Mayaji, et al. *Cell Rep. Phys. Sci.* 2.9 (2021).