



Ice Lithography progress between 2020 and 2026, and perspectives.

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Technological advances require the development of micro- and nanoscale components with smaller sizes, higher precision, and 3D features. This is essential in fields such as electronics, optics, microfluidics, communication, quantum technologies, and MEMS. Two-photon polymerization (2PP), focused electron beam-induced deposition (FEBID), focused ion beam-induced deposition (FIBID), and ice lithography (IL) are complementary additive manufacturing (AM) technologies that fabricate complex 3D objects at the submicrometer scale. Fundamentally different from 2PP and FEBID is IL. 3D IL is a layer-by-layer additive process involving freezing layers of a gasified precursor over the substrate surface and then patterning the obtained ice layers using an electron beam [1]. We demonstrated microfluidics and nanophotonic applications using 3DIL [1]. It can create features as small as 4 nm [2]. This talk introduces the IL process, summarize important developments in the recent 6 years, and presents opportunities for the future [3].

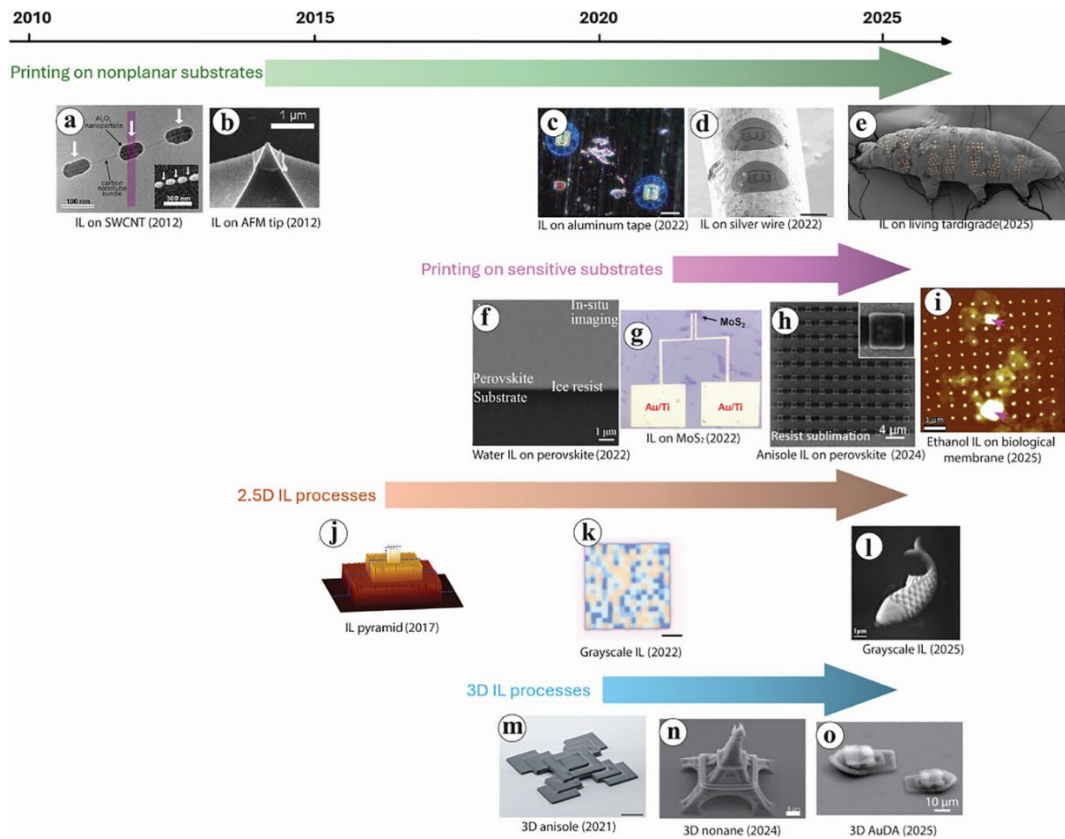


Figure 1. IL timeline

References

- [1] A. K. Waafi, et al. Additive Manufacturing, vol. 84, no. March, p. 104114, 2024.
- [2] A. Elsukova, et al. Nano Letters, vol. 18, no. 12, pp. 7576–7582, 2018
- [3] B. Chang, et al. Adv. Funct. Mater. 36, no. 12 (2026).

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