INSTRUMENTS AND METHODS OF INVESTIGATION

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3D printing methods for micro- and nanostructures

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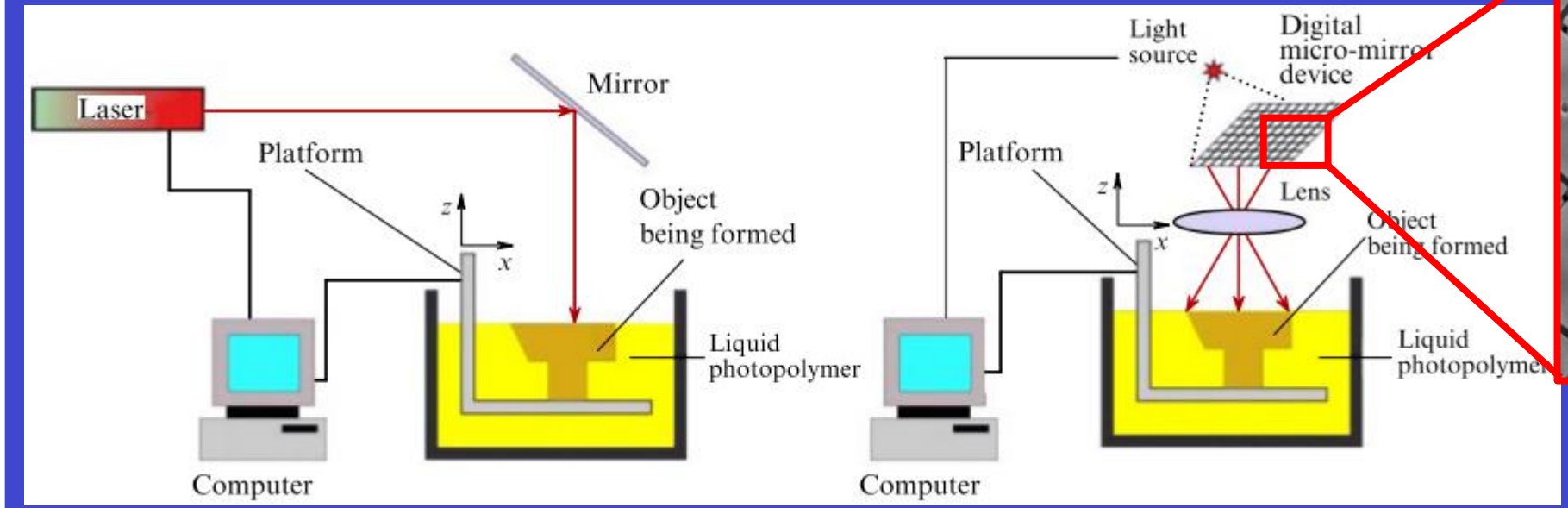
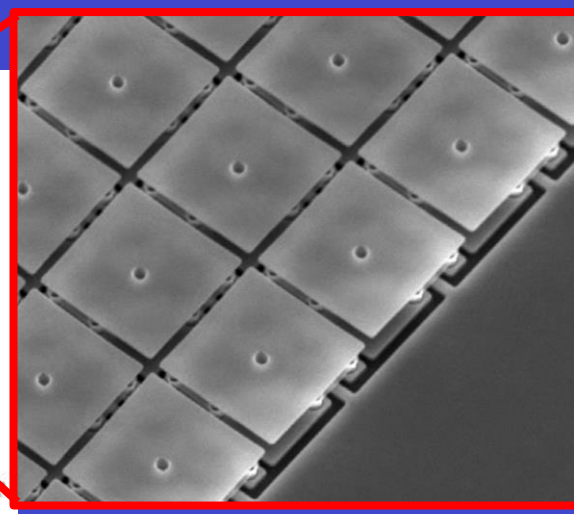
Nanostereolithography (Charles Hull, 1986)

Is one of the earliest and most popular additive manufacturing methods by layer-by-layer formation of 3D objects by photoirradiation.





10 by 10 μm mirrors

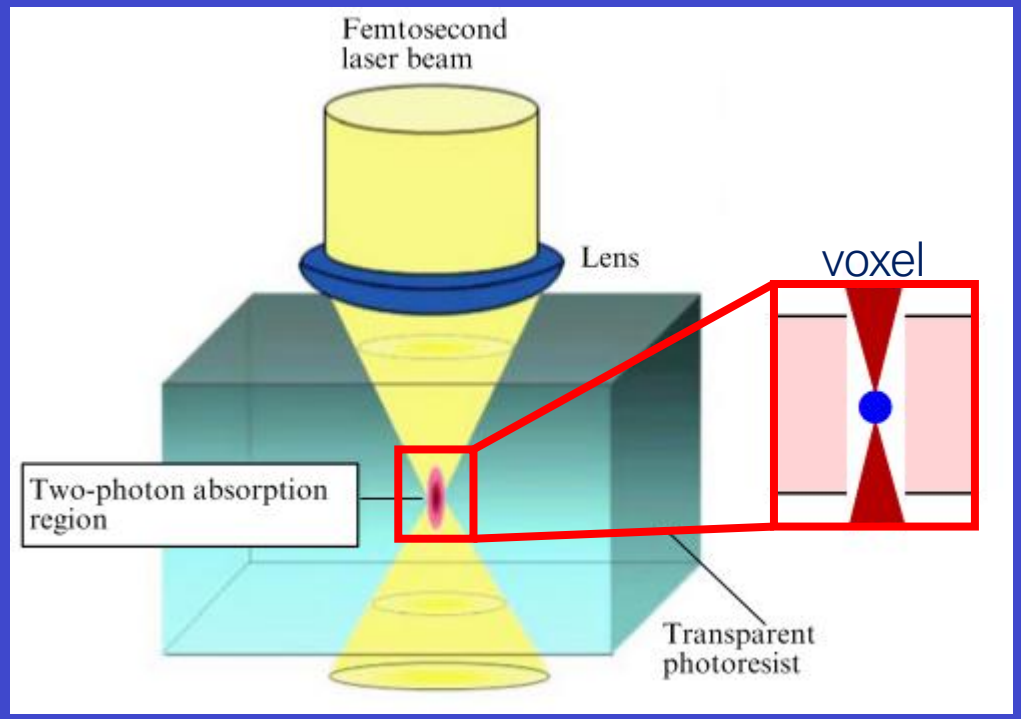
scanning stereolithography (point-by-point solidification)

projection stereolithography (layer-by-layer solidification)

How Digital Light Processing (DLP) works - YouTube, (n.d.). https://www.youtube.com/watch?v=9nb8mM3uEIc (accessed 20 May 2020).
Hull C W, U.S. Patent No. 4575330A (1986)

Two-photon polymerization (Maruo, 1997)

Enhancing the resolution of stereolithographic methods to about 1/100 the optical wave-length



Voxel size is multivariable dependent, hence hard to control

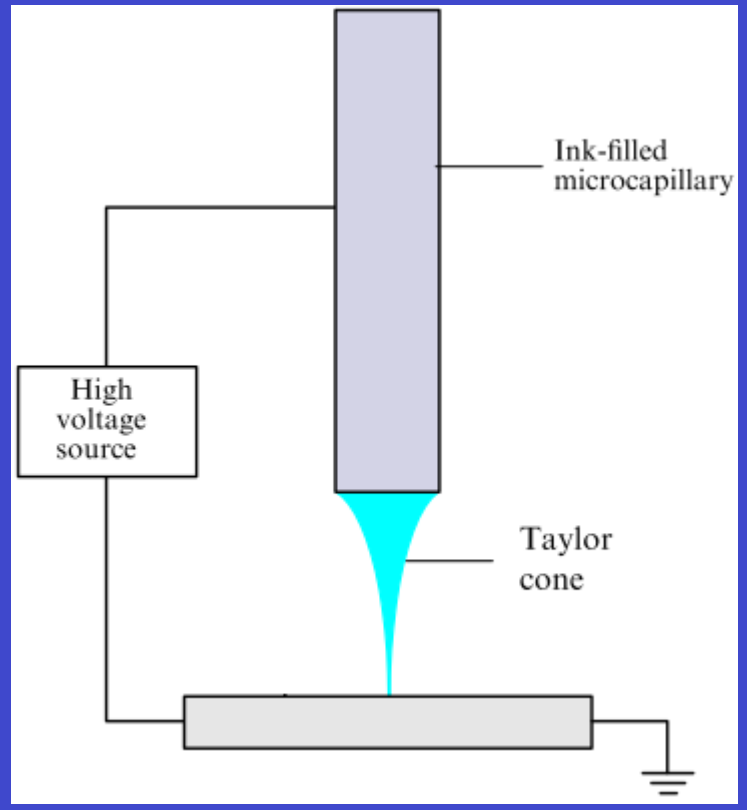
(radiation power and wavelength, oxygen diffusion, the radiation dose, and the properties of photoinitiators and monomers)

In short, a highly sensitive and efficient photoinitiator and a low laser radiation wavelength result in smaller objects

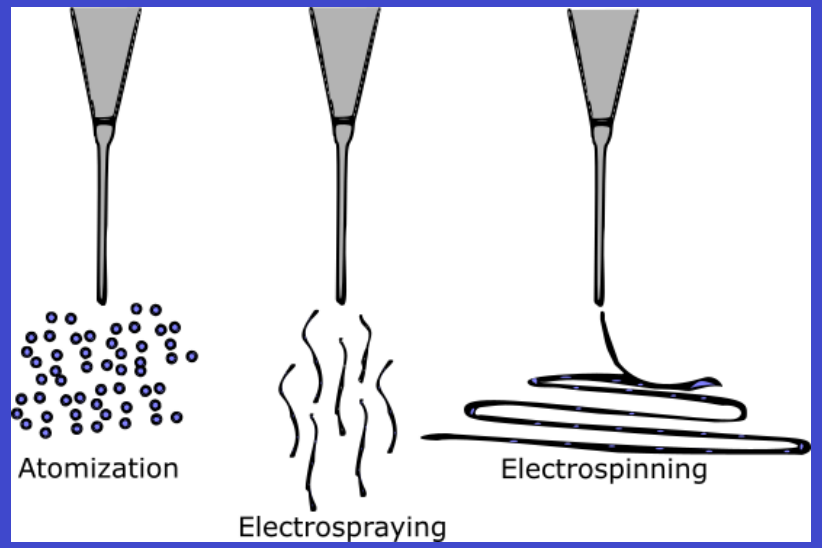
Maruo S, Nakamura O, Kawata S Opt. Lett. 22 132 (1997)

Electrohydrodynamic inkjet printing

Sequential selective deposition of ink droplets onto a substrate, just like when printing a document.



The jet diameter depends mainly on the electrodynamic force, rather than only on the ink viscosity as in conventional inkjet printing



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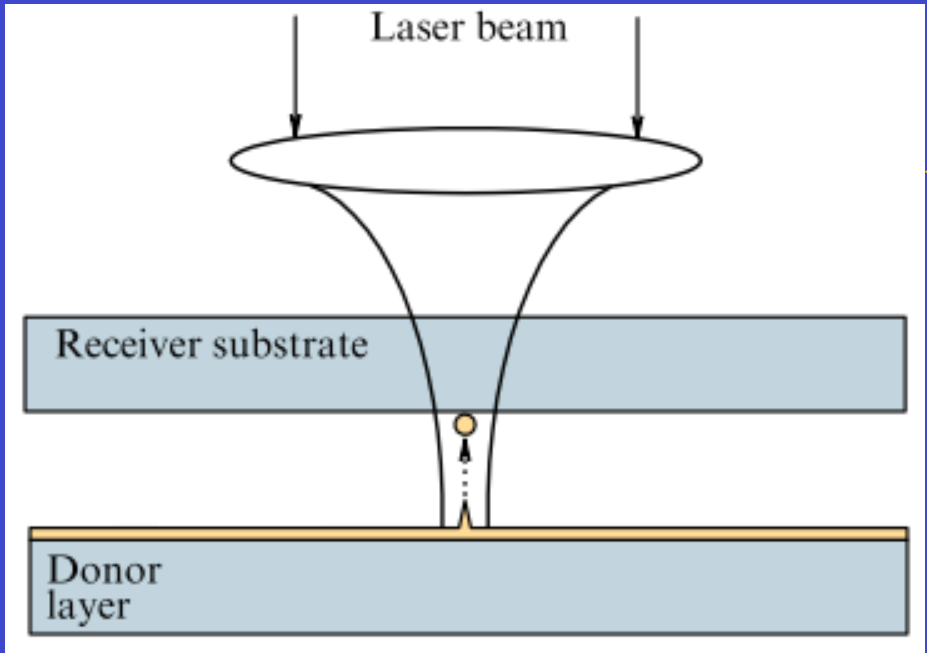
Laser-induced forward/backward transfer

The method is based on the transfer of a material from one substrate to another laser pulses.



Laser-induced backward transfer

heating, melting, and subsequent crystallization

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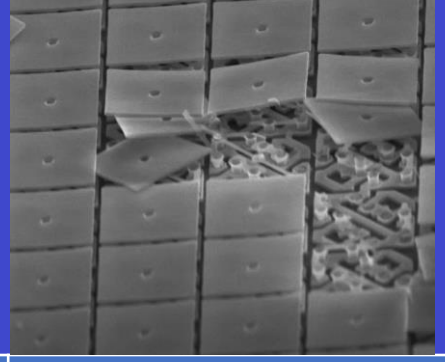
Conclusions:



Scanning stereolithography	Projection stereolithography	Two-photon polymerization
Slow, but easy to maintain	Faster, but more sensitive	More versatile, but voxel is hard to control
Resolution is limited by the radiation wave-length		Higher resolution
Very slow processes –> rate of mm per sec		

EHD Inkjet printing	Laser-induced transfer
Fast process (cm per sec), can yield droplets and fibers	free from nozzle clogging, but the donor material may change
scalable, low cost, variety of materials	
The ink/donor properties alter the process	

How Digital Light Processing (DLP) works - YouTube, (n.d.). https://www.youtube.com/watch?v=9nb8mM3uEIc (accessed 20 May 2020).
V. Galstyan, M. Bhandari, V. Sberveglieri, G. Sberveglieri, E. Comini, Metal Oxide Nanostructures in Food Applications: Quality Control and Packaging, Chemosensors. 6 (2018) 16


Q&A