

# Laser printing of nanoparticles and living cells

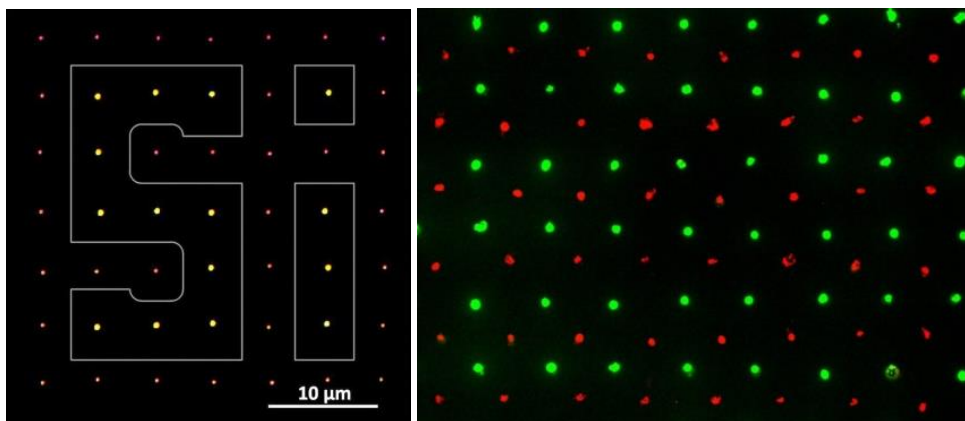
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## **Abstract**

Laser printing can be used for printing very small and delicate objects like 3D nanostructures, nanoparticles, and living cells. We will demonstrate several laser printing techniques allowing the generation and arrangement of spherical metal and dielectric nanoparticles in a very precise manner. For example, laser printed silicon nanoparticles are characterized by unique optical properties. With sizes in the range of 100-200 nm in diameter they exhibit pronounced electric and magnetic dipole resonances within the visible spectral range. The printed arrays of nanoparticles can be used as optical metasurfaces and nanosensors.

In a series of publications on laser printing of living cells we proved that cells are not harmed by the printing process. Different cell types, including primary cells, stem cells, and iPS cells embedded in hydrogels as extra-cellular matrix, have been printed. The differentiation behavior and potential of laser printed stem cells are not affected. Stem cells can be printed in defined patterns and then differentiated within these patterns towards bone, cartilage or adipose tissue. Furthermore, fibroblast and keratinocyte cells have been printed layer-by-layer to form 3D skin tissue constructs. The skin tissue formation has been proven by visualizing intercellular junctions and verifying their functionality.



**Fig. 1** Examples of laser printed arrays of Si nanoparticles, and living (endothelial and stem) cells.