

Nanoprinted Platforms for Topological and Neuromorphic Photonics

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Two-photon nanolithography (TPN) has emerged as a powerful laser-based fabrication approach to realize three-dimensional (3D) photonic architectures with sub-micrometric resolution and unprecedented control over geometry, symmetry, and optical functionality. Beyond conventional microfabrication, advanced laser writing strategies enable the direct engineering of complex dielectric structures where light propagation can be controlled through structural design. In this talk, I will discuss our recent progress in developing nanoprinted platforms for functional photonic devices, enabled by symmetry-preserving TPN and hybrid material processing. I will first present the realization of 3D photonic crystals and topological photonic structures, where nanoscale control over geometry and material composition provides access to engineered band structures, Weyl points, and symmetry-dependent optical responses. These systems demonstrate how laser-written architectures can be used to explore and control fundamental light-matter interactions in fully 3D environments. I will then show how the same fabrication concepts can be extended toward neuromorphic photonics through the realization of nanoprinted diffractive neural networks. By encoding trained optical transformations into diffractive elements, these devices perform passive, parallel information processing directly in the optical domain. Their compatibility with arbitrary substrates enables direct integration with CMOS sensors and microfluidic systems, opening opportunities for compact smart imaging and sensing platforms. Overall, these examples highlight TPN as a versatile route toward functional photonic materials, bridging laser-based surface engineering, nanophotonics, and emerging applications in optical information processing.