SYLA 1: Production Technologies for Integrated Photonic (Quantum) Systems

Time: Tuesday 11:00–12:30 Location: P 1

Invited Talk SYLA 1.1 Tue 11:00 P 1

3D printing of integrated optics on thin-film lithium niobate for quantum photonic applications — •Moritz Hinkelmann[1,2], Alexandra Rittmeier[1,2], Elisavet Chatzizyrli[1,2], Philipp Gehrke[1,2], Muhamed A. Sewidan[2,3], Andreas Wienke[1,2], Dietmar Kracht[1,2,3], and Michael Kues[1,2,3] — [1]Laser Zentrum Hannover e.V., Hannover, Germany — [2]Cluster of Excellence PhoenixD, Leibniz University Hannover, Hannover, Germany — [3]Institute of Photonics, Leibniz University Hannover, Hannover, Germany

In this contribution, we will review cutting-edge progress in 3D printing of integrated optics, emphasizing high-resolution techniques that enable rapid and sustainable photonic chip production, such as multi-photon lithography. Particular focus will be placed on thin-film lithium niobate, whose exceptional electro-optic and second-order nonlinear optical properties make this material one of the most promising candidates for quantum photonic applications. We highlight advances in fabricating low-loss optical waveguides - especially etchless, strip-loaded concepts that mitigate sidewall roughness while maintaining strong modal confinement. We discuss how these developments are accelerating the realization of compact, scalable quantum photonic integrated circuits. Initial results demonstrate that this approach can facilitate the production of a high-performance integrated device capable of generating entangled photon pairs through spontaneous parametric down conversion.

Invited Talk SYLA 1.2 Tue 11:30 P 1

Photonic Quantum Sensors and Their Fabrication Using Femtosecond Laser Micromachining — •Tobias Menold — Institut für Strahlwerkzeuge, Universität Stuttgart, Pfaffenwaldring 43, 70569 Stuttgart

Ultrafast lasers are an extremely versatile tool for fabricating integrated devices in transparent materials, particularly in the fields of microelectronics, advanced packaging, and integrated photonics. Their potential is especially relevant in the emerging field of quantum sensing, which is currently transitioning toward industrialization and practical applications. By leveraging ultrafast lasers, it is possible to fabricate nearly all passive components of integrated photonic circuits on glass-based substrates. Furthermore, these circuits can be coupled with quantum sensors, such as vapor-cell-based devices, providing a scalable manufacturing route for miniaturized architectures of quantum sensors. This talk presents an overview of possible manufacturing techniques, illustrated through a demonstrator of a quantum-based gyroscope. Such a device represents a breakthrough in navigation, with transformative applications in autonomous driving, navigation of small aerial vehicles such as drones, and defense-related Positioning, Navigation, and Timing (PNT) capabilities particularly in scenarios where Global Navigation Satellite Systems (GNSS) may be compromised through jamming or spoofing.

Invited Talk SYLA 1.3 Tue 12:00 P 1

3D printed micro-optics: Novel fabrication enabling innovative designs — •Michael Schmid, Simon Thiele, and Nils Fahrbach — Printoptix GmbH, Nobelstraße 15, 70569 Stuttgart, Germany

In recent years, 3D direct laser writing (also known as 2pp), has established itself as an irreplacable tool to fabricate complex micro-optical systems.

From the initial prototype fabrication in the academic field, the fabrication method has established itself on the commercial field, offering annual production in the 100.000s of complex, user defined micro-optical parts.

The design possibilities of 3D printed optics on the μm up to mm scale are unmatched, enabling unique optical designs with outstanding performance. This includes monolithic free-form aspheric multi-lens systems, the combination of refractive, diffractive and reflective optics, as well as different lens materials with varying dispersion, and the integration of apertures. Both, illuminating and imaging optics, as well as holographic optics, can be 3d printed. These possibilities offer innovative optical designs in various fields such as endoscopy, beam shaping, and microscopy.