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Fundamentals and Application Potentials of Nano & Quantum Photonics

Abstract

Key words: nano optics, quantum photonics, metadevices, quantum photonic circuits, photonic integrated circuits

Nanophotonics and integrating photonic devices are already essential components in sensing, data transmission, and data processing systems, where besides their essential functionality they help to decrease the related consumption of energy. However, unlike the highly standardized silicon electronics platform, photonic integration has still not found its one and only technology, and it is very likely that a broad technology portfolio including also hybrid approaches will be the basis for nanophotonic integration also in the future. Particularly the availability of multiple thin-film materials with versatile optical properties has provided photonics with new platforms, which pave the way towards truly integrated optical devices. Our work is based mainly on nanostructuring silica, silicon on insulator, and lithium niobate on insulator, but also reaches out to materials like titanium oxide, gallium phosphide, and transition metal dichalcogenides. These materials and the related nanostructure technologies offer a broad range of versatile optical properties, which makes them fitting to specific applications.

Besides these materials and their novel nanofabrication technologies, we explore also new design degrees of freedom for realizing nanophotonic circuits based on so-called metasurface. Realizing large-scale devices based on such sophisticated designs is extremely demanding for the nanotechnologies, since it requires smallest nanosized features with large aspect ratio in combination with ultra-low surface roughness and extreme global positioning accuracy. Hence, we will present also recent advances in the nanofabrication of wafer-scale nanostructured photonic devices.

On this basis we are addressing several emerging application fields, in e.g. imaging, sensing, and information processing, with both, classical and quantum light. We will discuss the state of the art and share our perspective on upcoming developments in the field.

CV

Thomas Pertsch is a professor of applied physics at Friedrich Schiller University Jena (Germany), where he leads the “Nano- and Quantum Optics Group” at the Institute of Applied Physics. He serves as the university’s Vice-President for Research and Innovation and one of the directors of the Abbe Center of Photonics (www.acp.uni-jena.de). After studying electrical engineering at Technical University of Dresden

(Germany) and Rensselaer Polytechnic Institute in Troy (USA), he completed his doctorate in physics at University Jena.

His current research focus is on the generation and interaction of light with nanostructured matter, including metamaterials, photonic crystals and integrated quantum optical devices. As the speaker of the Abbe School of Photonics (www.asp.uni-jena.de) and Fellow of the Max Planck School of Photonics, he is committed to the internationalization of research-oriented photonics education in Germany. He teaches mainly in the field of photonics and computational physics.