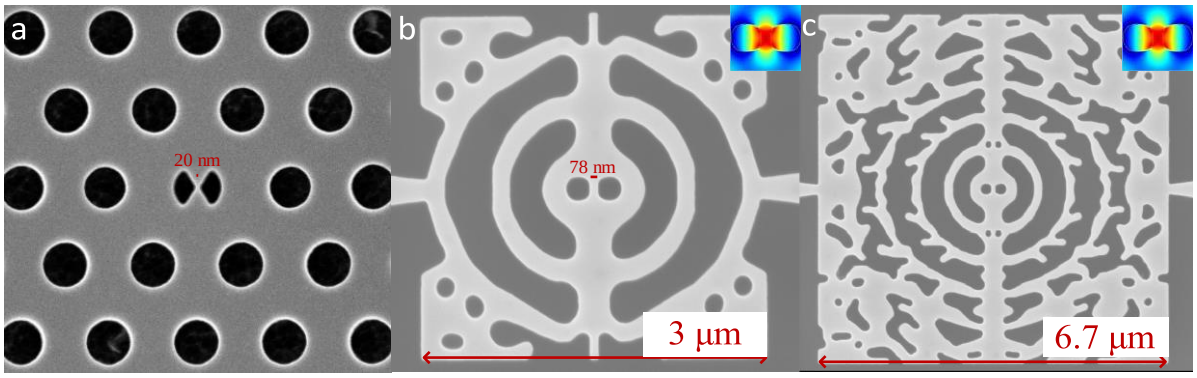
ANNUAL HIGHLIGHTS

In the second year of NanoPhoton, we continued our quest to explore the possibilities offered by enhanced light-matter interaction in optical cavities with extreme dielectric confinement (EDC).

As a major scientific highlight of the second year, we saw the first light from fabricated EDC lasers with several different designs (see figure below) in indium phosphide with embedded quantum wells as active material. Building on the experience from the silicon fabrication, the indium phosphide structures feature dimensions as low as 20 nm, which leads to extreme optical field confinement in the central region. This demonstration represents an important milestone for the research centre, as the ability to fabricate lasers with footprints on the microscale is central to the NanoPhoton vision of on-chip optical-electronic interconnects. Additional scientific highlights include the development of a novel droplet-based epitaxy for growth of indium arsenide quantum dots on indium phosphide, which overcomes the problem of asymmetry in the quantum dot shape and enables applications in quantum communication [1], as well as the interesting prediction that the quantum optical phenomenon of polariton blockade due to non-linear exciton-exciton interaction is possible by use of two-dimensional materials coupled to nanoscale electromagnetic resonators, such as the EDC cavities studied in NanoPhoton [2]. As a last scientific highlight, we mention the fabrication and characterization of an ultra-coherent Fano laser, showing that a so-called bound state in the continuum can be used to significantly reduce the spectral linewidth of micro- and nano-scale lasers [3].

Two tutorial papers on inverse design were published in Journal of the Optical Society of America B (JOSA B) in early 2021 [4-5]. Both papers featured on the JOSA B top downloads list for several months in a row following their publication, and one of them [4] featured on the JOSA B 2020-2021 most cited papers list. It still features on the JOSA B top downloads list as of January 2022, and has been awarded with the ISI Highly Cited emblem on Clarivate Web of Science.

2021 saw the official and somewhat delayed opening of NanoPhoton, at which we welcomed the DNRF chair Jens Kehlet Nørskov and the DTU president Anders Overgaard Bjarklev, along with colleagues and students, for a festive inauguration of the research centre. Having completed the second year of the centre, we are happy that NanoPhoton member Yi Yu was able to secure additional funding through a Young Investigator Grant from the Villum Foundation. In the early fall, we all gathered for a three-day workshop to exchange ideas and develop new ones. With 9 new colleagues having joined NanoPhoton in 2021, the research centre is shaping up fast.



Scanning electron micrographs of fabricated EDC lasers. (a): Zoom-in of a Point-defect Photonic Crystal with a central bowtie feature. (b) and (c): Tolerance-constrained topology optimized cavities with different footprints. The insets show the electric field in the central part of the cavities.