Integrated perovskite light emitters

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Metal-halide perovskites are ideal candidates for optoelectronic on-chip devices. In this talk we will demonstrate our latest achievements in integration of perovskite light emitters into Back-end-of-line compatible photonic platforms (Si_3N_4).

Recently, top-down lithographic patterning processes have been established in spite of the chemical sensitivity of perovskites. The first integrated devices show lasing thresholds that can compete with other technologies. Other recent works demonstrate continuous wave lasing operation and raising hopes for electrically pumped device concepts in the future. At the same time, monolithic integration onto different photonic substrates is feasible. This makes the integrated perovskite devices unique and, in the near future, more versatile compared to existing concepts such as hybrid-integrated III-V lasers.

In this talk we will demonstrate our latest achievements in integration of optoelectronic devices. Fabrication processes and treatment of the perovskite material has to be optimized differently in order to obtain efficient light emitting devices in comparison with photovoltaic applications. We work on a silicon nitride photonic platform and integrate perovskite processes seamlessly in our photonic fabrication line. The overall performance of the integrated devices is strongly dependent on the morphology of the used materials. First attempts of reducing the perovskite's surface roughness and increasing the lateral dimensions of crystallites show the perspective of lowering laser threshold by order of magnitude. Scattering losses can be mitigated and thus polarization of the generated laser light can be stabilized. All devices work at room temperature and are currently optically pumped. Different types of perovskites (i.e. $MAPbI_3$ and $CsPbBr_3$) are integrated onto silicon nitride photonic chips. The generated laser light can directly be used by the photonic circuit underneath the perovskite laser. The emission is characterized after outcoupling through a silicon nitride waveguide. Furthermore, a detailed study about the optical properties of the perovskite after patterning by photolithography is carried out in order to define design optimizations needed for the future light emitting devices.

Our work focusses strongly on reproducible, mass manufacturable fabrication processes. Long term device stability is a central challenge for newly developed material and devices geometries. Possible industrial applications such as datacom and sensor devices are discussed.