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Ferroelectric Integrated Photonics

Within the last years, there has been a meteoric rise of research on ferroelectrics-based integrated photonics platforms, chief among them Lithium Niobate. Lithium niobate is the workhorse of electro-optical modulator technology due to its high Pockels (i.e. electro-optical) coefficient, and low optical loss These circuits offer ultra-fast, linear, and efficient optical modulation allowing CMOS-compatible high-speed modulators operating at volt levels, for applications ranging from data-center communications to quantum transduction, neuromorphic computing or ultra-fast tunable lasers.

In this talk I will summarize our recent work on the development of ultra-low loss integrated photonic circuits based on thin-film ferroelectric materials. High-quality photonic integrated circuits are either fabricated via wafer-bonding of unprocessed thin films to functional silicon nitride photonic Damascene passive components or via direct physical etching of the thin film to form the waveguide core using a diamond-like-carbon hard mask. We achieve waveguide propagation losses of less than 0.1 dB/cm in all platforms lowest achieved losses in the range of 3 dB/m. I will discuss the application of ferroelectric integrated photonics for ultra-fast tunable lasers for frequency -modulated continous wave LiDAR achieving modulation frequencies as high as 10 MHz with GHz continuous tuning range and dissipative Kerr soliton generation.

Lastly, I will present very recent experimental and theoretical results on the fundamental thermodynamic noise limit of the laser linewidth and the observation of a novel thermodynamical noise mechanism that is not driven by temperature fluctuations but by charge density fluctuations and which we have observed for the first time in integrated optical microring resonators.

References

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