



# KOLLOQUIUM

Institut für Elektrotechnik, Elektronik und Informationstechnik

## **Photonic Integration for High Density and Multi-Functionality in the InP-Material System**

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Cauerstraße 7/9, Hörsaal H5

**Diskussionsleitung: Prof. Dr. R. Weigel**

Progress in photonics by monolithic integration for higher functional density, performance and reduced cost faces challenging hurdles due to technological and functional heterogeneities of optoelectronic technology. Advanced local material growth techniques and the emerging photonic crystal (PhC) technology are enabling concepts towards high-density photonic integration, unprecedented performance and multi-functionality allowing ultimately for optical systems-on-a-chip.

After a brief introduction of the research activities of at the Electronics Laboratory at ETH, Zürich the presentation starts with an assessment of the current status and future challenges of monolithic photonic integration in the InP-material system. We then first present our work on a multi-section monolithically integrated mode-locked InP/InGaAsP-laser as a case study in photonic integration for future Tb/s OTDM-systems. To generate stable sub-ps optical pulses @  $\lambda=1.55\mu\text{m}$  directly from the laser an ultrafast uni-travelling carrier (UTC) absorber has been integrated by multiple MOCVD-regrowth into an actively mode-locked laser with a MQW-InGaAsP/InP optical amplifier and passive waveguides. The structure demonstrated in a preliminary experiment optical pulses below 600fs.

Second we discuss our results on a InP-based PhC-technology suitable for the integration of passive and active PhC-based devices and the related fabrication challenges. We perforate a vertically weakly guiding InP/InGaAsP/InP-waveguide with deeply etched air holes (4 $\mu\text{m}$  deep for a <300nm diameter) using ICP-based dry-etching subsequently to highly accurate proximity effect correction and e-beam lithography. End-fire characterization or novel SNOM-measurements of PhC-devices such as waveguide transitions, splitters and a novel standing-wavemeter will be presented. Due to the substantial out-of-plane scattering losses of low-contrast 2D-PhC we developed 2D simulation tools including synthetic losses for fast prototyping/optimization that are calibrated against 3D-PDTD-simulations and measurements.

The potential of PhC-technology is not limited to its own specific functionalities and revolutionizing size-reduction for OICs, but also leads to performance, size and functional enhancement of conventional devices. Manipulation of dispersion, filtering and strong nonlinearities caused by the high photon density opens up possibilities for high performance lasers, modulators, detectors and all-optical switches and are also reviewed by addressing the state-of-the-art in these emerging fields..