DETECTION AND GENERATION OF CO₂ LASER PULSES

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ABSTRACT

The quality of laser-based material processing is, among others, strongly affected by the spatio-temporal characteristics of the incident laser radiation. As a result, there is a growing interest in laser pulse generation, laser pulse detection and the visualization of the (time dependent) laser beam intensity distribution.

In this work we present opto-electronic semiconductor based devices targeting the CO₂ laser spectrum. The focus of this thesis is twofold. On the one hand we investigated a novel evanescent wave modulator for Q-switched laser pulse generation. On the other hand we focused on the visualization of the spatio-temporal behavior of CO₂ laser radiation by exploiting the thermo-electric (Seebeck) effect in doped semiconductors (e.g. n-GaAs, n-Si). Special attention is paid to the multi-physics modeling, the design parameter optimization process and the experimental validation of the devices.

In the context of laser pulse generation, we furthermore studied the CO₂ laser dynamics in function of different laser and modulator parameters. The principle of transverse laser mode switching or partial spatial modulation is presented as a novel means to improve the Q-switching performance of most existing modulator principles and as an enabling technology for the RC-time constant limited evanescent wave modulator.

In the context of laser pulse monitoring, developments towards a high power (multi-kW) CO₂ laser beam profiler are presented. This includes the investigation, implementation and demonstration of special techniques for thermal cross-talk reduction and beam shape recovery. Implementations of one dimensional focal-plane-arrays (FPA’s) are shown.