SU2P [ĕs ū tōō pē]: *an innovative bridging project connecting Scottish and Stanford Universities; an industry-academic interaction; entrepreneurial activity in photonics*

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Introduction

Terahertz (THz) wave generation based on parametric frequency down conversion in electro-optic crystals is one of the techniques, which opened the path towards compact tuneable THz sources, capable of emitting at continuous-wave (CW) to femtosecond (fs) pulses, all conveniently operable at room temperature. The process is known as difference-frequency generation (DFG). Terahertz generation via frequency down conversion in electro-optic crystals is a promising approach for producing powerful and tunable THz sources, which is further enhanced through the progress in both new quasi-phase-matched (QPM) dielectrics as well as new powerful infrared pump sources. However, optical-to-THz conversion efficiency is intrinsically low. Beyond the achievements with electro-optic crystals, III–V semiconductors (for instance GaP or GaAs) are very attractive for QPM THz-wave generation since they possess several appealing properties. They provide THz absorption coefficients, which are smaller by an order of magnitude with a superior thermal conductivity. In addition semiconductor materials show promise in being much more efficient in comparison to electro-optic materials.

Results

Record THz output levels were achieved at Stanford University, reaching 1 mW-level average power, generated via difference frequency generation in a QPM GaAs placed inside a cavity of a doubly resonant synchronously pumped type-II picosecond optical parametric oscillator (OPO). This record was achieved with a linear cavity. The linear approach had the benefit of an excellent time control of signal and idler overlap at the two nonlinear crystals inside the cavity. However, due to the two individual resonators, spatial mismatch was easily introduced, which lowers the conversion efficiency. Hence a ring-cavity was introduced to overcome the spatial mismatch as well as to improve the resonator stability against thermal lensing of the GaAs crystal using the doubly resonant optical parametric oscillator (DROPO). The results of the experiment showed that thermal management of the gallium arsenide plays a major role. The entire locking electronic with piezo transducer as well as the GaAs crystal, mount, and controller was handed over to Microtek Inc., a company trying to commercialize a THz source based on the DROPO approach.

Personal

My experimental skills were developed a lot due to the broad experience in infrared source development and THz handling and detection. Building doubly resonant OPOs was a very good extension to my OPO experience that I brought over from Scotland. Taking over the task of locking several cavities with the TEM LaseLock was a difficult but rewarding task. We were able to stabilize systems reliably with unprecedented stability.

My new position in the Hänsch Group at the Max-Planck Institute for Quantum Optics would have been impossible without the SU2P Fellowship and the skills acquired at Stanford.