PhD Thesis Defense CHAITANYA KUMAR SUDDAPALLI 'High Power, Fiber-Laser-Pumped Optical Parametric Oscillators from Visible to Mid-Infrared'

CHAITANYA KUMAR SUDDAPALLI

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Wednesday, January 18, 11:00. ICFO Auditorium

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Nonlinear Optics

ICFO-The Institute of Photonic Sciences, SPAIN

High-power, continuous-wave (cw), mid-infrared (mid-IR) laser sources are of interest for variety of applications such as trace gas detection and remote sensing, which require broad

spectral coverage to address the most prominent absorption features of a wide range of molecular species particularly in the mid-IR fingerprint region. On the other hand, surgical applications require high energy sources with unique pulse structure at specific wavelength in the mid-IR ranging from 6-6.5 m.

Optical parametric oscillators (OPOs) offer potential sources for all the above applications. The output wavelengths of a singly-resonant oscillator (SRO) can be coarsely tuned over wide ranges through the adjustment of the nonlinear crystal temperature, phase-matching angle or, in the case of quasi-phase-matched (QPM) materials, the QPM grating period. The combination of SRO with a tunable pump laser allows the development of uniquely flexible and rapidly tunable class of mid-IR sources.

In this thesis we have demonstrated several mid-IR OPOs in the cw as well as ultrafast picosecond regime pumped by fiber-lasers making them compact and robust.

In the cw regime, we developed a high-power, Yb-fiber-laser pumped mid-IR OPO based on MgO:PPLN spanning 1506-1945 nm in the near-IR and 2304-3615 nm wavelength range in the mid-IR, efficiently addressing the thermal effects by implementing the optimum signal output coupling. Novel materials such a MgO:sPPLT, with better optical and thermal properties for cw mid-IR generation are explored. High-power broadband, cw mid-IR generation is also demonstrated by using the extended phase-matching properties of MgO:PPLN.

Further, we also demonstrated a simple, inexpensive and novel interferometric technique for absolute optimization of output power from a ring optical oscillator. We deployed a picosecond Yb-fiber-laser pumped mid-IR OPO based on MgO:PPLN in ring cavity configuration to demonstrate this proof-of-principle experiment for the first time. The high-energy CSP OPO marked the first demonstration of a compact, high-repetition-rate OPO synchronously pumped by a master oscillator power ampli?er system at 1064 nm, generating an millijoule pulses in the 6-6.5 m spectral range, which is technologically important fo surgical applications.

Additionally, we also demonstrated a fiber-based-green source at 532 nm, based on single-pass second harmonic generation (SHG) in MgO:sPPLT, as an alternative pump source for Ti:sapphire laser, pointing towards the future, compact fiber-laser pumped Ti:sapphire

lasers. Further efforts to improve the SHG efficiency led to the development of a novel multi-crystal scheme, enabling single-pass SHG efficiency as high as 56%. This generic technique is simple and can be implemented at any wavelength.

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Thesis Advisor: Prof. Majid Ebrahim-Zadeh