Congratulations to New ICFO PhD Graduate

Dr. Biplob Nandy graduated with a thesis entitled i¿½Developme t and Study of Novel Mid-Infrared Frequency Conversion Sources"

December 02, 2020

We congratulate Dr. Biplob Nandy who defended his thesis today in ICFO's auditorium with online participations due to social distancing to contain the Coronavirus pandemic.

Dr. Nandy received his MSc in Physics from the Indian Institute of Science Education and Research. He joined the Optical Parametric Oscillators research group led by ICREA Prof. at ICFO Dr. Majid Ebrahim-Zadeh to carry out his PhD studies on Nonlinear Optics. Dr. Nandy's thesis entitled i¿½Development and Study of Novel Mid-Infrared Frequency Conversi n Sourcesi¿½ was supervised by ICREA Prof. at ICFO Dr. Majid Ebrahim-Zadeh and Dr. Chaitanya K. Suddapalli.

ABSTRACT:

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Tunable narrow-linewidth and broadband laser sources in the mid-infrared (mid-IR) wavelength range are extremely desirable in all time scales for their several useful applications in spectroscopy, imaging, optical communication and medical sciences to name a few. The one very important application of high-power tunable narrow-linewidth mid-IR laser sources in the 2 m wavelength range is the ability to pump cascaded mid-IR optica parametric oscillators (OPO) for generating tunable wavelengths beyond 4 m usi g semiconductor nonlinear crystals such as ZnGeP2 (ZGP) or orientation patterned Ga s (OP-GaAs). These crystals have very good linear and nonlinear optical properties along wi h good transparency beyond 4 m wavelengths unlike oxide-based materials such as MgO:PPLN which have strong multi phonon absorption beyond 4 m wavelengths. Howe er, both ZGP and OP-GaAs cannot be pumped by commercially available 1 m lasers d e to linear and nonlinear absorptions below~2 m wavelengths. In this thesis, w have demonstrated some very useful high-power narrow linewidth tunable 2 m nanosec nd and picosecond high-repetition-rate sources with very good spatial beam qualities. e have further demon strated a picosecond mid-IR idler-resonant MgO:PPLN based O O with intra-cavity second-harmonic-generation (SHG). This helps in covering the es ential wavelength gap between 1.064 m and 1.45 m when pumped by Yb- ber laser at .064 m. This wavelength gap is generally not covered by MgO:PPLN based SROs that re signal resonant due to the material transparency of MgO:PPLN which doesn't allow the idl r wave to go above ~4 m wavelength, thereby restricting the signal wave from reaching elow ~1.45 m.Due to the requirement of synchronous pumping, the OPOs typically tend to b relatively bulky and of large size, which can restrict its practical utility in space constrained applications. We address this challenge by demonstrating a compac picosecond high-repetition rate singly resonant (SRO) with intracavity-mirror-retro-re ecto ber (IMRF) that enables two-fold reduction in the form-factor. This IMRF OPO demonst ates a high wavelength tunability from~1.45 m to~4 m with high spectral brightness and exceptionally good output beam quality. In our attempt to further reduce the size and complexity of nonlinear frequency conversion sources, we have demonstrated the rst singl -pass optical parametric generation (OPG) and ampli cation (OPA) in MgO:PPLN wi h record high conversion e ciency of >59% without the requirement of any seed- aser. We have demonstrated a record-low pump threshold energy of 7.5 nJ which is remark bly small and opens a whole new area of research on single-pass frequency conversion de ices based on OPG/OPA. Our system is highly tunable near~2 m region with >8 W of sin le-pass output power while pumped with~14 W of pump power at 1064 nm. Finally, in this hesis, we have demonstrated the rst phase-locked picosecond OPO with record high o tput power and spectral bandwidth near~2 m wavelength region. Such a device can b used as a high spectral brightness phase-locked super-continuum source for a huge array of applications.

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