Congratulations to New ICFO PhD Graduate

Dr Sukeert graduated with a thesis entitled ï¿½Versatile nonline r frequency conversion sources in the near- and mid-infraredï¿½

March 09, 2022

We congratulate Dr Sukeert who defended his thesis today in ICFO's auditorium with online participations.

Dr Sukeert obtained his MSc in Physics from the University of Hyderabad, India. He joined the Optical Parametric Oscillators research group led by ICREA Prof Dr Majid Ebrahim-Zadeh to carry out his PhD studies on novel frequency conversion and OPO sources for spectroscopy, imaging, and frequency metrology. Dr Sukeert's thesis entitles ?Versatile nonlinear frequency conversion sources in the near - and mid-infrared' was supervised by ICREA Prof Dr Majid Ebrahim-Zadeh and Dr Chaitanya Kumar Suddapalli.

ABSTRACT:

Tunable laser sources in different spectral regions are of interest for a variety of applications including spectroscopy, trace gas sensing, medical diagnostics, LIDAR and material processing. Existing lasers have limited tunability and many spectral regions continue to

remain inaccessible to lasers due to lack of suitable gain media. Nonlinear frequency conversion is a viable approach to cover such difficult spectral regions in the visible, near and mid-infrared (mid-IR).

Optical parametric oscillators (OPO) can provide wide wavelength tunability with high output powers in good beam quality across continuous-wave (cw), nanosecond and ultrafast picosecond and femtosecond time-scales. With the development of quasi-phase-matched (QPM) nonlinear materials in fan-out grating structure, wide wavelength tuning is possible at a fixed temperature, enabling the development of rapidly tunable devices for practical applications. Difference-frequency-generation (DFG) is also an attractive approach for generating high powers in the mid-IR in a single-pass scheme.

In this thesis, we have developed second-order nonlinear frequency conversion sources based on nanosecond and cw OPOs and cw DFG. Widely tunable green-pumped OPOs have been developed by using fan-out grating structure for the first time in different nonlinear materials, and a high-power cw source in the mid-IR has been developed by exploiting DFG. The sources developed in this thesis cover a wavelength range spanning 677-2479 nm. One of the OPOs developed in this work has also been deployed in an industrial environment in a device characterization setup.

In green-pumped OPOs, we demonstrate a widely tunable cw OPO based on PPKTP in a fan-out grating structure. The OPO is continuously tunable across 742-922 nm in the signal, and 1258-1884 nm in the idler. Resonant wave output coupling has been deployed to extract useful signal power and reduce the thermal load, and the OPO can deliver up to 1.65 W of total output power. The use of output coupling results in superior performance of the OP over pure singly-resonant oscillator (SRO) configuration

We also develop the first green-pumped OPO based on MgO:cPPLT. Continuous wavelengt tuning across 689-1025 nm in the signal and 1106-2336 nm in the idler at room temperatur has been achieved in the nanosecond OPO by using a fan-out grating structure. The OPO ca provide up to 131 mW of average output power at 25 kHz repetition rate, and the idl r passive power stability is 3.9% rms over 30 minute

. A cw OPO based on MgO:PPLN in a fan-out grating design is then described. The OPO s continuously tunable across 813-1032 nm in the signal and 1098-1539 nm in the idler. A sho t crystal length and signal output coupling are used to minimise thermal effects, and the O O can generate up to 710 mW of total output power with signal and idler passive pow r stabilities better than 2.8% rms and 1.8% rms, respectively over 1 hour and signal M^2<1.

. As a part of an industrial internship, a cw green-pumped MgO:PPLN OPO is developed t Radiantis. The OPO is used as the input light source of a device characterization setup to te t sensors for the aerospace sector. Compared to the existing light source, using the O O results in orders-of magnitude-higher response of the InGaAs sensor, leading to a mo e precise and accurate characterization, and lower measurement error, thus improving he device evaluation proce

s. Finally, we demonstrate a high-power cw source at 2.26 ?m using the DFG process.
he source can deliver up to 3.84 W of output power at 2262 nm, with a power stability bet
er than 0.6% rms over 1 hour, in a Gaussian mode profile with M^2<1

Thesis Committee:

Prof Dr Antoniangelo Agnesi, Universita di Pavia
Dr Pablo Loza Alvarez, ICFO
Prof Dr Christian Pedersen, Technical Unviersity of Denmark ?