Subnanosecond fan-out MgO:PPLN optical parametric amplifier using continuum seed

Simona Armalytė[1], Jonas Banys[1], Vygandas Jarutis [1], Julius Vengelis[1]
[1]*Laser Research Center, Faculty of Physics, Vilnius University, Saulėtekio av. 10, 10223, Vilnius, Lithuania*
simona.armalyte@ff.stud.vu.lt

Parametric light generators (OPGs) and amplifiers (OPAs) offer a simple single-pass design, low cost, high peak power, and excellent robustness while obtaining a wide spectral tuning in the IR region [1]. They are therefore widely used in applications such as pump-probe spectroscopy, gas detection, skin disease treatment, LIDAR, THz generation, in various nonlinear optics experiments, etc. [2-3]. Some applications require tunable laser radiation of subnanosecond (300 ps - 1 ns) duration, but such parametric frequency converters in particular are relatively poorly realized, due to the difficulties caused by the laser-induced damage threshold to the nonlinear medium (LIDT), which, for most materials, is lower than the threshold for parametric generation with subnanosecond pulses. Due to the high nonlinearity coefficient, OPG and OPA are often based on quasi-phase matching crystals, i.e. periodically poled crystals. The fan-out grating design used in this work is characterized by the fact that the grating periods change uniformly over the entire length of the crystal at a single fixed temperature, which enables obtaining a uniform tuning of the wavelengths simply by laterally translating the crystal. This tuning method is superior to temperature tuning because it is more convenient, faster, and more precise.

This study aimed to enhance the conversion efficiency of a subnanosecond optical parametric amplifier with a 25 mm length fan-out grating design MgO:PPLN crystal, whose grating period changes continuously from 27.5 µm to 31.6 µm, by using a continuum seed radiation. The crystal was pumped by a passively Q-switched Nd:YAG MOPA microlaser generating 1064 nm wavelength pulses with an average power of 1 W, 520 ps pulse duration and a repetition rate of 1 kHz. The continuum used as seed was generated in a photonic crystal fiber (PCF). Since seed spectrum covered the entire signal wave tuning range (1414 nm – 2128 nm), the conversion efficiency improvement of ~6% – 11% was achieved for all OPA compared to unseeded OPG signal wavelengths and the generation threshold was reduced up to 3 times. This shows that using continuum seed can be an effective way to reduce the risk of MgO:PPLN optical damage and improve the energy stability of the parametric device. A maximum conversion efficiency of 45% for unseeded OPG and 51% for OPA in the degeneracy region was achieved (Figure 1)[1].

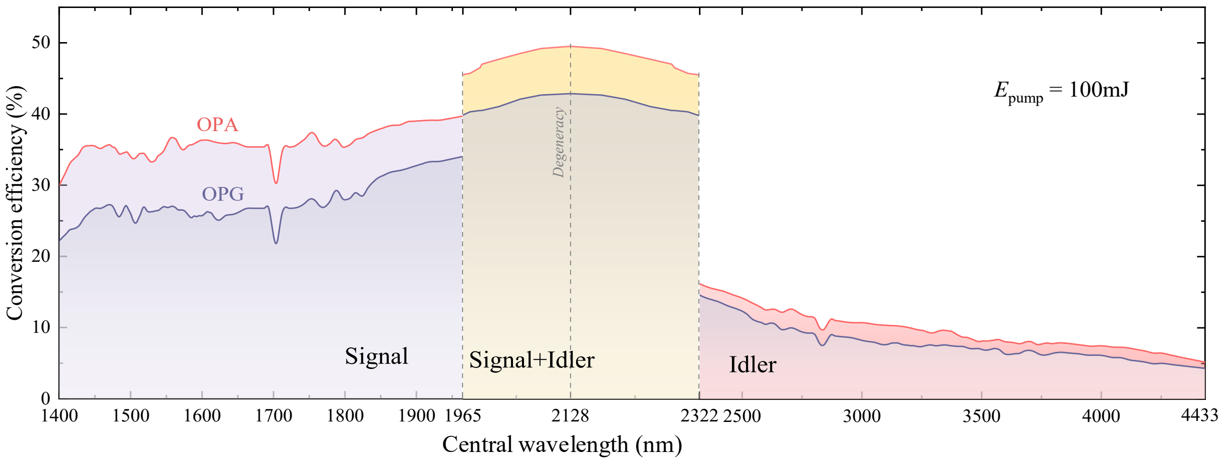

Fig. 1. The comparison of unseeded OPG and OPA conversion efficiencies throughout the tuning range at a pump energy of 100 µJ.

[1] For the 1965 nm to 2322 nm wavelength range (Figure 1), the spectral separation between signal and idler wavelengths was unattainable as their spectra were either partially or entirely overlapped, consequently, for these wavelengths, we determined the total (signal+idler) conversion efficiency.

References

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