

HIGH ENERGY kHz MID-IR TUNABLE PPSLT OPO PUMPED AT 1064 NM

Danail Chuchumishev, Alexander Gaydardzhiev, Anton Trifonov, Ivan Buchvarov
Department of Physics, Sofia University, 5 James Bourchier Blvd., BG-1164 Sofia, Bulgaria
Corresponding author: ivan.buchvarov@phys.uni-sofia.bg

Sub-nanosecond coherent sources tunable in the mid-IR spectral region (2.5-4 microns) have wide-ranging medical and material science applications based on the vibrational bands of the organic molecules that are in this spectral range. Many of these applications require optical pulses shorter than the characteristic thermalization time of the material, and pulse energies sufficiently high enough for material ablation. In addition the average power of the laser has to be large enough to enable “high - throughput” and acceptable product yields. Optical parametric oscillators (OPO) based on highly nonlinear periodically poled (PP) quasi phase-matched (QPM) materials pumped by 1 micron Q - switched lasers are an effective way to obtain the required radiation. Recently, there have been studies with PPLN based OPOs in the mid-IR, either at high repetition rate (1-10 kHz) and very modest output energy (few microjoules) or at low repetition rate (tens of Hz) and high output energy (>mJ), but consequently very modest output power [1,2].

Here, we report a single frequency sub-nanosecond OPO based on periodically poled stoichiometric lithium tantalate (PPSLT), pumped by an amplified microchip laser at 1064 nm at a repetition rate of 0.25-1 kHz. Using a 11 mm long PPSLT crystal poled with three different domain periods (30.2, 30.3, 30.4 μm) and changing the temperature of the crystal from 20°C to 265°C, we achieved wavelength tuning between 2990 nm and 3500 nm. The experimental results are in very good agreement with the theoretically calculated curves, where we used the Sellmeyer equations [3]. The high nonlinearity of the used medium and the large aperture (2 mm) ensure maximum idler output energy of >0.5 mJ in the whole tuning range, corresponding to average ~13% conversion efficiency (overall quantum conversion efficiency ~42 %) and over x100 mW of average power. Sub-nanosecond pulse durations were obtained for the idler as a result of the 1 ns pulse duration of the pump. We employ a 11 mm long, 10 mm wide, and 2 mm (along z axis) thick PPSLT crystal with three different poled zones with domain inversion periods (30.2, 30.3 and 30.4 μm respectively). The crystal is with very high stoichiometry ratio (49.94% Li_2O / 50.06% Ta_2O_5), ensuring low coercive field (800 V/mm) and high poling quality. Due to the short duration of the pump in order to increase the idler cavity roundtrips the OPO cavity length is chosen as short as possible i.e. 23 mm. The idler pulse duration is obtained by measuring the pulse duration of its frequency doubled pulse in a 5 mm thick KTP crystal and then deconvoluted with the measurement setup response function (470 ps). Thus the idler pulse duration is found to be 714 ps, shorter than the undepleted pump pulse duration (1 ns). The obtained average power is limited by the damage threshold of the OPO rear mirror and potentially reaching of watts level of output power is obvious by replacing the metal rear mirror with dielectric one. **Acknowledgements:** We acknowledge financial support under grants D02-134/2009 and partially DRG02-4/2009 of the Bulgarian Ministry of Science and Education.

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