20-50 kHz High Efficiency Mid-Infrared OP-GaAs OPO pumped by a 2 µm Holmium Laser

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We report on what is, to our knowledge, the best results obtained with a 2 µm-pumped OP-GaAs OPO. Slope efficiencies are as high as those obtained with ZGP OPOs pumped with the same Ho:YAG laser [1].

The 2.090 µm beam of a Q-switched Ho:YAG laser (M^2~1.2) pumped by an IPG-Tm:fiber laser [2] is focused to a 100 µm 1/e²-intensity radius spot inside the OP-GaAs sample linearly polarized along the crystal growth direction. The Ho:YAG pulse duration depended on pulse repetition rates and average output power. At maximum output power, it varied from 60 ns at 20 kHz to 150 ns at 50 kHz. The OP-GaAs sample tested is 5 mm wide, 450 µm thick and 20 mm long with ~63 µm-grating period. The growth process was described elsewhere [3]. It is antireflection coated at pump as well as at signal and idler wavelengths (3-5 µm). Optical losses in the HVPE film mesured at 2.090 µm were lower than 0.02 cm^{-1}.

The pump beam is single passed in the 22 mm long OPO cavity consisting of a flat input mirror transmitting 90% of the pump beam and reflecting signal and idler and a 50% reflecting output mirror at both signal and idler wavelengths. It has a radius of curvature of – 50 mm.

The average output power for repetition rates varying from 20°kHz to 50 kHz is plotted versus the average pump power incident upon the input mirror in figure 1a. Pump intensity was limited to avoid damage to the crystal. Optical-to-optical slope efficiencies are about 60%-55% for repetition rates tested comparable with slope efficiencies of ZGP OPOs pumped with the same Ho:YAG laser [1]. The signal and idler beams are elliptical due to diffraction at the crystal aperture and for maximum output power at 20 kHz (1.6 W), their beam propagation-factor was estimated in the perpendicular axes directions. M_X^2 is about 1.9 and M_Y^2 1.5 for the signal beam and M_X^2 is about 2.1 and M_Y^2 1.4 for the idler beam (figure 1b).

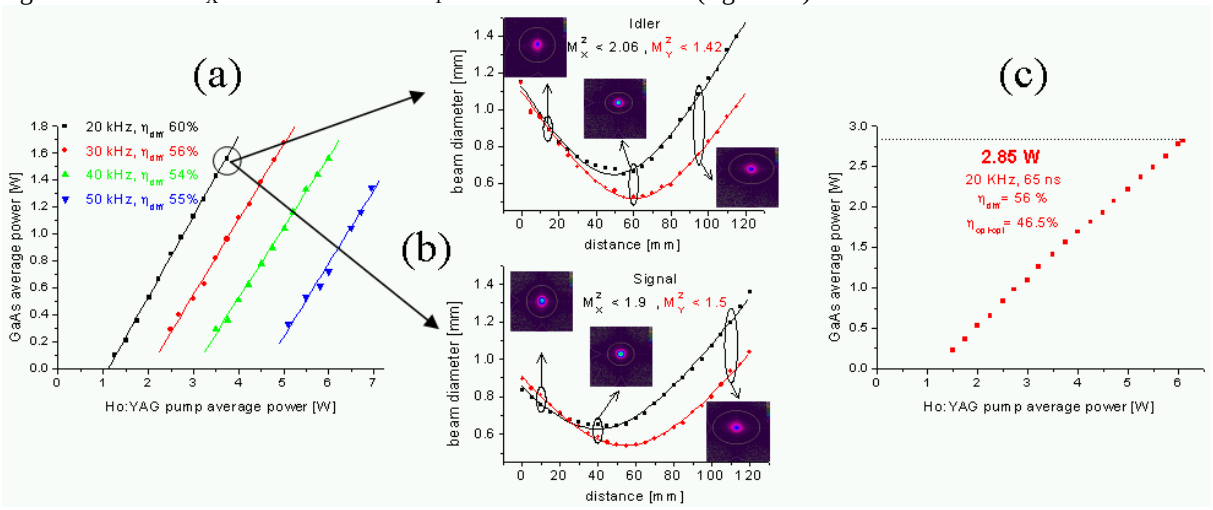

Fig. 1: OP-GaAs OPO output power versus Ho:YAG pump power for repetitions rates from 20 to 50 kHz (a), estimation of beam propagation-factor (b), best results obtained at 20 kHz before damage (c).

At 20 kHz, average output power was plotted versus average pump power before laser-induced damage was observed. Up to 2.85 W are obtained for 6.1 W of pump power, corresponding to an optical-to-optical conversion efficieny of 46.5% with a threshold of 1 W (figure 1c). The damage corresponds to a fluence of about 2 J/cm². The thickness of the sample limited the pump power.

References

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