

fabricated. A 3 W level output was obtained from this tunable OPO in the 3-5 μm range (signal + idler) with a 53% conversion efficiency and an unprecedented beam quality ($M^2 = 1.4$). The output beam from the OPO also offers more than 3 W of additional power at the 2.1 μm pump wavelength. This compares very favorably with former designs based on PPLN crystals, both in terms of power and beam quality. Figure 6 shows what the device looks like in addition to more recent results obtained by Hildenbrand et al. using a more powerful pump [15] and demonstrating that a 10 W level mid-IR source is a most probable prospect.

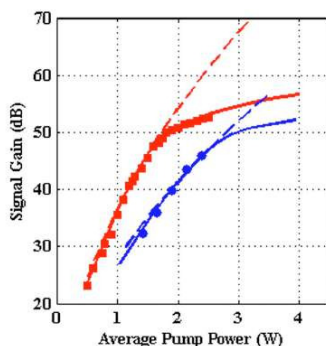


Fig. 7. Gain versus pump average power. Squares (Circles), experiment with a 41-mm-long (32-mm-long) crystal. Solid curves, theoretical fits with SNLO calculation; dotted curves, with non-depleted pump approximation.

Last but not least, both continuous wave and pulsed regimes have been merged in an experiment targeting mid-infrared remote sensing by optical parametric amplification of a distributed feedback quantum cascade laser (QCL) in OP-GaAs [16]. Using a 3 mW DFB QCL at 4.5 μm and less than 3 W of average pump power from a 20 kHz 30 ns Q-switched Ho:YAG laser at 2.1 μm , it was possible to demonstrate a gain up to 53 dB (see Fig. 7). The amplified beam had a very good beam quality ($M^2 = 1.3$) and its peak power reached 600 W.

5. Conclusion

The fabrication of Orientation-patterned Gallium Arsenide crystals has lately witnessed significant progress and this non-linear optical material has now reached maturity for several applications requiring mid-infrared photons with power or wavelength ranges not easily available through other sources.

OP-GaAs is routinely grown on 2-inch wafers at TRT with a simple process for initial wafer periodic patterning, resulting in the capability to produce 0.5 mm thick samples with several centimeters length. Thanks to the optimization of the growth process, absorption losses have been reduced down to 2%/cm or less and the sample thickness recently increased to the millimeter level. Such material improvements have enabled to demonstrate nanosecond pulsed OPOs with several watts of average output power in the 3 to 5 μm range and optical to optical conversion efficiencies of about 50%. They may also soon permit the realization of millijoule level sources and continuous wave devices with large tunability

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