Frequency Shifting of High Power Laser Radiation by Stimulated Raman Scattering in Crystals

H. J. Eichler[a1], H. Rhee[a], V. A. Orlovich[b] and V. A. Lisinetskii[b]

[a] Institute of Optics and Atomic Physics, Technische Universität Berlin, Straße des 17 Juni, Berlin, Germany
[b] B. I. Stepanov Institute of Physics, NAS of Belarus, Nesalezhnasti Ave. 68, Minsk 220072, Belarus

Stimulated Raman scattering (SRS) has been observed in more than 100 crystals generating about 2000 different wavelengths covering the ultraviolet, visible and infrared spectral regions with a mean spacing of 1 nm. Barium nitrate crystals have been used to demonstrate high Raman shifted output energy up to 156 mJ or high average power of 10 W at 1.197 μm, 1.369 μm and 1.599 μm wavelengths with quantum efficiencies of up to 66%.

The frequency of pulsed Nd:YAG- and other fixed wavelength lasers can be down- or up-shifted by SRS. Cascading Stokes or anti-Stokes processes produce frequency combs covering the infrared to ultraviolet spectral range. Nitrate, tungstate, vanadate, molybdate, sulfate, germanate, fluoride and, amongst others, organic transparent crystals and ceramics have been investigated in order to increase the number of obtainable frequencies [1]. Different ways for generation of high power radiation in the IR region by SRS in barium nitrate were investigated:

- A Raman laser generating up to 156 mJ at the first (1.197 μm) and 104 mJ at the second Stokes wavelength (1.369 μm) using an L-shaped cavity. Third Stokes (1.599 μm) radiation with energy of 116 mJ was generated in a linear cavity. The quantum efficiencies were up to 66 %. For all configurations a repetition rate of 10 Hz was used with pulse duration of 20 - 30 ns. The Raman laser bandwidth was less than 0.5 cm^{-1} [2].

- A Raman laser with high average power at first Stokes (output power – 10 W, quantum efficiency – 20 %) or third Stokes (output power – 5 W, quantum efficiency – 17 %) wavelength. Compensation of the thermal lens was shown for operation at a repetition rate of 100 Hz.

- A Raman amplifier where low divergent first Stokes radiation was amplified up to 63 mJ with quantum efficiency of 34 %. The M^2 factor of the amplified radiation was about 2. The gain was up to 1600 so that this device is useful for low-power narrowband seed-laser amplification [3].

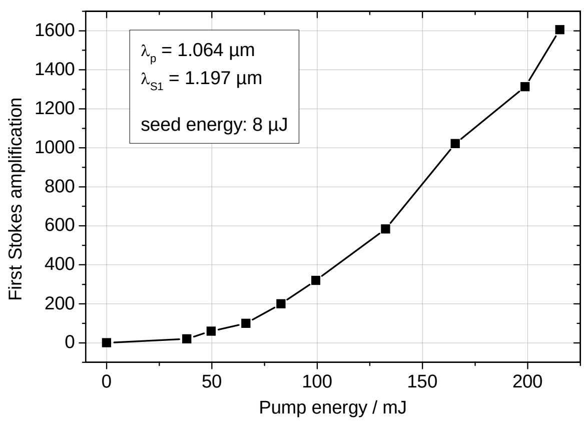

Fig. 1. Amplification of first Stokes radiation at small seed energy in dependence of the pump energy.

[1] Kaminskii A.A., Rhee H., Eichler H.J., Ueda K., Takaichi K., Shirakawa A., Tokurakawa M., Dong J., Yagi H. and Yanagitani T., Las. Phys. Lett. **5**(2), 109-113 (2008)

[2] Lisinetskii V.A., Grabtchikov A.S., Khodasevich I.A., Eichler H.J. and Orlovich V.A., Opt. Commun. **272**(2), 509-513 (2007)

[3] Lisinetskii V.A., Grabtchikov A.S., Orlovich V.A., Eichler H.J. and Rhee H., Proc. SPIE, Int. Conf. on Lasers, Appl., and Technol., LAT 2007 (2007)

[1] E-mail: eichler@physik.tu-berlin.de