Development of a high power transverse diode pumped Nd:YAG rod module

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Reliable and robust diode-pumped solid-state oscillators and amplifiers with high output power, high efficiency and good beam quality are required in numerous industry applications and research areas (W. Koechner, 2007). Integral part of these systems is the diode-pumped laser module (chamber), whose characteristics determine to large extend the output parameters of the entire laser setup. For high output-power operation usually side-pumping is used and thus various pump configurations have been studied. Main focus of attention has been the development of an efficient transverse pump reflective optical systems, for which different options exist, i.e. compound parabolic (cylindrical) concentrator optical transport systems, silver- or gold-coated reflectors or diffusive reflectors ensuring uniform distribution of the pump intensity over the crystal rod. Although the diffusive ceramic reflectors are commonly used in pump chambers (H. Moon *at al.*, 1999), the ceramic reflectivity is comparably low ~96%, and the fabrication process is somewhat demanding.

In the present work we demonstrate two designs of high-power transversely diode-pumped Nd:YAG modules with improved reflector cavities based on the relatively new thermoplastic material Fluorilon-99W, which possesses high diffusive reflectivity (above 99 % at 808 nm), it is easy to fabricate and is thermally stable up to 300 ºC. Each module employs dia.6-mm x 80-mm Nd:YAG rods mounted in a water-flow tube in the center of diffusive optical reflector. In the case of three-fold geometry (Fig.1a) three slits (70 mm length, 1.5 mm width) were cut into the reflector allowing direct illumination of the laser crystal by three linear diode arrays (6x40W). In the five-fold geometry (Fig.1b), five pump diode arrays were optically coupled with the laser rod through waveguide glass plates (65x1.2x4 mm) mounted in the reflector. When designing the modules, we took special care in minimizing the slit (plate) widths, aiming to decrease the pump losses.

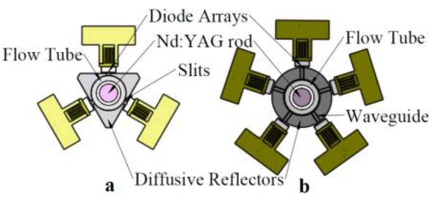

Figure 1. Schematics of the constructed modules.

We investigated the characteristics of the three-fold geometry module employing short (215 mm) flat-flat resonator with T=10 % output coupler. Lasing at 1064 nm started at 151 W of CW pump power (808 nm), the measured slope efficiency was 44%. We were able to reach a CW maximum output of 250 W, when pumping with 720 W. The measurements of the strength of the thermally induced lens, by a collimated He-Ne laser beam, show focal length from 0.8 Dpt to 2.5 Dpt for pump power 180 W and 500 W, respectively. At all levels of the output power, the observed beam spot was round with no apparent hot spots, signifying for homogeneous distribution of the pump intensity over the cross-section of the rod.

An imaging beam profiler was used to measure the fluorescence intensity integrated along the rod axis for the case of five-fold geometry module. The observed distribution is homogenous over the central 3 mm of the aperture. However, the high concentration (0.8% at) of the Nd^{3+} in crystal causes absorption of significant amount of the pump power in the first 2.5 mm of the crystal depth, close to the diode arrays. Currently we aim to ensure homogenous pump distribution over the entire aperture of the rod by optimizing the geometry of reflector cavity and selecting crystal with optimal Nd^{3+} concentration and diameter.

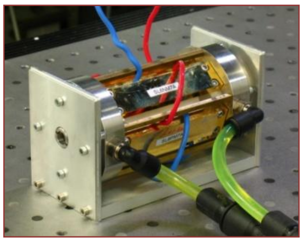

Figure 2. Prototype of fivefold geometry module.

The presented work shows an intermediate stage (Fig.2) in the development process aimed towards the construction of a high-energy (~100mJ) and high-average power (~100W) master-oscillator power-amplifier system. We plan to equip this system with a down-conversion stage for mid-IR generation in order to explore its potential for advanced medical applications.

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W. Koechner: *Solid-State Laser Engeneering* (Springer Series in optical sciences, 2007);

H. J. Moon *at al.*, Efficient Diffusive Reflector-Type Diode Side-Pumped Nd:YAG Rod Laser with an Optical Slope Efficiency of 55%, *Appl. Opt.*, (1999), **38,** 1772;