High efficient diode side pumped Nd:YVO_4 laser with good beam quality with a novel configuration

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We demonstrated a cw side pumped $Nd:YVO_4$ laser with high power output and a improvement in beam quality. Using a compact cavity with less than 8 cm overall length, we obtained very high conversion efficiency and slope efficiency in multimode operation and 21.9 watts of output power. With a novel compact three mirrors cavity we improve significantly the beam quality using a second pass inside the gain media maintaining high output power.

The laser crystal is a $Nd:YVO_4$ with 1.1 at.% neodymium doping and dimensions of $22 \times 5 \times 2mm^3$. The pump source was a 48 watt TM-polarized diode bar operating at 808 nm. The TM polarization is parallel to the c-axis of the crystal and hence accesses the high absorption coefficient of 31.4 cm^{-1}.

In a first experiment we used two mirrors, one flat mirror with 36% transmission and other of 50cm radius of curvature. We did one single pass through the gain media with one total internal reflection. A 6.4mm cylindrical lens was used in front of the diode bar in order to focus the pump radiation into the crystal. In a second experiment we used a double pass configuration with a second total internal reflection at the pump face. We used a novel configuration with only three mirrors, a high reflector flat mirror, a flat mirror with 36% transmission and other of 50cm radius of curvature. The same crystal and cylindrical lens in front of the diode bar was used.

In the single pass configuration we achieved a slope efficiency of 69% with 21.9 watts of output power in multimode with M^2 of 24.6×10.4 in horizontal and vertical directions, respectively, while with the double pass configuration we achieved 17 watts with M^2 of 3.4×3.8 in the horizontal and vertical directions, respectively. We conclude that a second pass improved the beam quality and demonstrated this with a compact three mirrors cavity.