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End-Pumped Double-Clad Waveguide Laser

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Abstract:

We report 1.3W of near-diffraction-limited output from a 4W broad-stripe diode end-pumped double-clad Nd:YAG waveguide laser fabricated by direct bonding.

Summary

The use of a double-clad guiding structure to allow efficient pumping by non-diffraction-limited high-power diodes, and yet still obtain diffraction-limited laser output, has been extensively studied in optical fibres[1]. Recently, a one-dimensional version of this technique has been applied to planar waveguides, allowing the development of very compact, proximity-coupled, diode-bar side-pumped waveguide lasers[2]. CW powers of >10W have been obtained in this way[3] but, with the use of a monolithic plane/plane cavity, the output is still highly non-diffraction-limited in the non-guided direction. Here we investigate the use of similar double-clad structures end-pumped by a 4W broad-stripe diode obtaining >1W in a beam with measured M^2 values of 1.0 by 1.8. Figure 1 shows the waveguide structure used in these experiments.

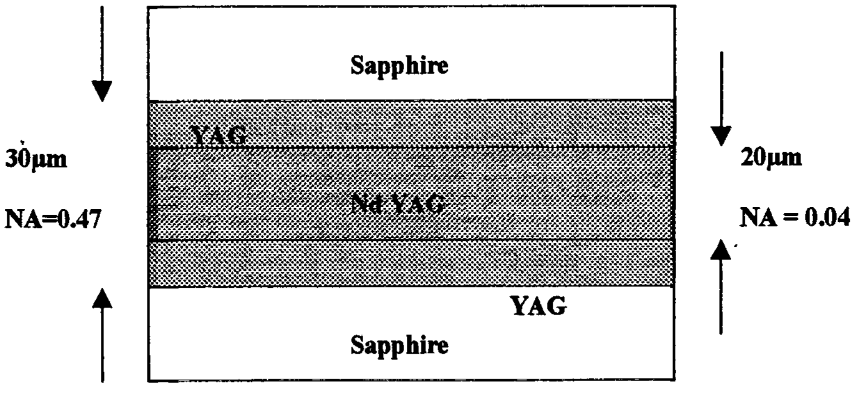

Fig.1 Double-Clad Planar Waveguide Structure

The 1cm long guide was fabricated by direct bonding by Onyx Optics. The 4W 808nm broad-stripe diode laser was obtained from Boston Lasers and has an emission width of 200µm. After fast-axis collimation the diode had measured M^2 values of 4 by 40 in the fast and slow axes respectively. The large numerical aperture (NA) sapphire/YAG guide can easily contain the focused diode light, which is gradually absorbed by the central doped region. In contrast to double-clad fibres, where a strictly single mode core is normally used at the expense of a large increase in the absorption length, here single guided mode laser operation is obtained due to the restriction of the gain to the central region of a multimode composite guide. This design allows a much smaller increase in absorption length and so is more suited to compact planar devices. Due to the better beam quality of the broad stripe diode in the slow axis compared to diode bars, simple cylindrical lens focusing can lead to efficient end-pumping with a relatively narrow gain region, allowing near-diffraction-limited output from a plane/plane monolithic cavity. Initial results have given M^2 values of 1.0 by 1.8 in the guided and non-guided planes for operation at 1.064µm, with output powers of up to 1.3W. Figure 2 shows a typical output mode imaged onto a CCD camera.

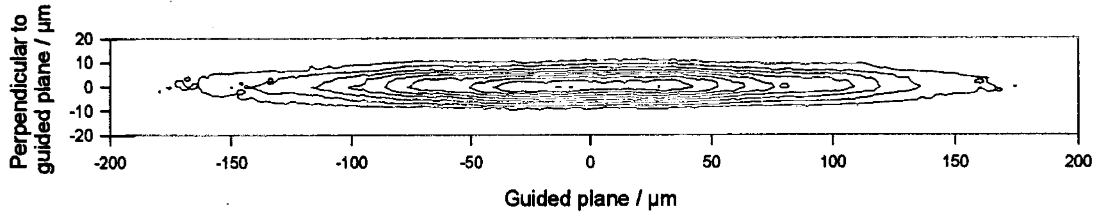

Fig. 2 Output mode profile imaged on a CCD camera

Lasing at 946nm and 1.32µm has also been demonstrated and, without optimization of the output coupling, >0.5W and >0.3W of output power have been obtained respectively. Increasing the output power to several Watts by polarization coupling of two pump diodes, the use of integrated components such as passive q-switches[3] to increase functionality, and moving to wavelengths which can be harder to produce as bulk lasers such as 3µm Er:YAG, could make this an attractive option for compact laser sources.

References

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