Efficient Holmium-doped solid-state lasers pumped by a Tm-doped silica fiber laser

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In-band pumping of Ho-doped solid-state lasers by a cladding-pumped Tm fiber laser is an attractive route to high output power and high pulse energy in the eyesafe two-micron spectral region. This approach combines the advantages of fiber lasers and crystal solid-state lasers with relative immunity from the effects of thermal loading, nonlinear loss processes (e.g. stimulated Brillouin scattering) and energy-transfer-upconversion. The use of a Tm-doped fiber laser as the pump source allows a great deal of flexibility, since the broad emission linewidth allows the wavelength to be tuned over a very wide range spanning the absorption lines of interest in Ho:YLF, Ho:YAG and many other Ho-doped crystals.

In this paper, we report efficient operation of Ho:YAG and Ho:YLF lasers pumped by a tunable Tm-doped silica fiber laser. The lasing wavelength of the Tm-doped fibre laser could be tuned over 150nm from ~ 1860 to 2010nm with a relatively narrow linewidth (<0.5nm) and at output power levels in excess of 9W. Using a simple standing-wave cavity configuration, >6.4W of TEM_{oo} output was obtained from a Ho:YAG laser at 2.1μm at the maximum incident pump power of 9.6W, corresponding to an optical-to-optical efficiency of 67%, and the slope efficiency with respect to incident pump power was 80%. By comparision, for a similar resonator design, 4.8W of output at 2.07μm was generated from a Ho:YLF laser at an incident pump power of 9.4W, corresponding to an optical conversion efficiency of 51%. Using a simple ring resonator geometry and an acousto-optic modulator to enforce unidirectional operation, we have obtained 3.7W of single-longitudinal-mode output from a Ho:YAG laser. The prospects for further improvement in performance and higher output power will be discussed.

Key words: Tunable Tm:fiber laser, Single frequency, Ho:YAG, Ho:YLF