UNIDIRECTIONAL Nd-DOPED PHOSPHATE GLASS RING LASER USING THE ACOUSTO-OPTIC EFFECT IN THE LASER MEDIUM

W.A. Clarkson and D.C. Hanna
Optoelectronics Research Centre
University of Southampton
Southampton, S09 5NH

D.S. Lovering and G.C.W. Jones
Gooch and Housego Ltd.
Ilminster
Somerset, TA19 OAB

Enforcing unidirectional operation of a ring laser using an intracavity travelling-wave acousto-optic (A-O) modulator can be an effective way to achieve both efficient and reliable single frequency operation [1]. Recently, it has been shown that there are two distinct mechanisms [2],[3],[4] which are responsible for the non-reciprocal behaviour of a travelling-wave A-O modulator, and in both cases it has been demonstrated that a sufficient value of loss difference to ensure unidirectional operation can be achieved at very low r.f. powers. This fact suggests that many laser materials, not previously noted as having a high enough figure of merit for many acousto-optic applications, may nevertheless prove to have a more than adequate figure of merit for A-O unidirectional devices.

In this paper we describe a useful extension of the acousto-optic technique for enforcing unidirectional operation of a ring laser in which the laser medium is also the A-O modulator. The resonator design used (shown in Fig.1), is a simple three-element ring cavity which contains a Brewster-angled, travelling-wave A-O modulator, fabricated from Nd-doped phosphate glass. This was designed to operate with a r.f. drive of 250MHz and produced a maximum diffraction loss (at 1.053μm) of $\sim 1\%$ for an applied r.f. power of 1W. When pumped by a 1.2W, high-brightness diode, preliminary results indicated that the lasing threshold occurred at an incident pump power of approximately 230mW. The maximum output power achieved was limited by thermally-induced stress birefringence to $\sim$85mW for a pump power of 560mW. Unidirectional and single-frequency operation were achieved by applying a low power r.f. signal ($\sim$0.008W) and aligning the modulator close to the Bragg condition.

In view of the very low values of acousto-optic figure of merit required for A-O unidirectional devices confirmed by this experiment, it is anticipated that many other laser materials will prove appropriate for this scheme of unidirectional operation. This offers the prospect of a number of very compact and stable, all-solid-state, single frequency ring lasers.

References

[1] W.A. Clarkson and D.C. Hanna, Opt. Comm. **81**, 375 (1991).
[2] W.A. Clarkson, A.B. Neilson and D.C. Hanna, Opt. Lett. **17**, 601 (1992).
[3] M.K. Reed and W.K. Bischel, Opt. Lett. **17**, 691 (1992).
[4] W.A. Clarkson, A.B. Neilson and D.C. Hanna, Opt. Comm. **91**, 365 (1992).

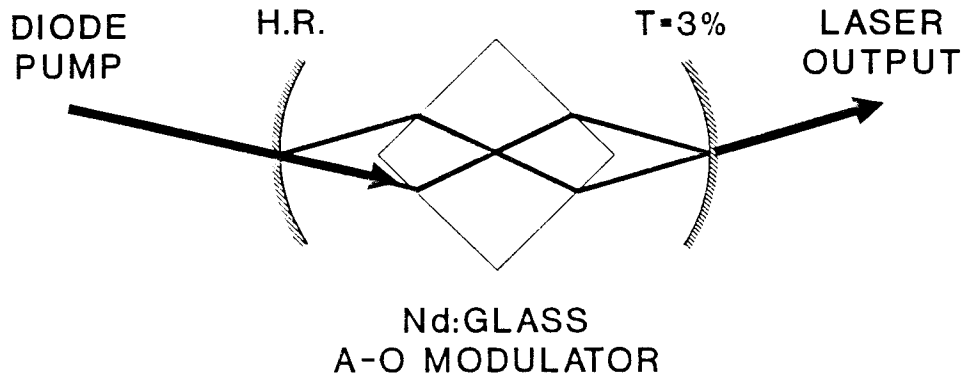

Fig. 1. Diode-pumped Nd-doped phosphate glass ring laser.