Ti:sapphire rib waveguides as single-transverse-mode broadband fluorescence sources for optical coherence tomography applications

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ABSTRACT

Ar^+-beam-milled rib waveguides in pulsed-laser-deposited Ti:sapphire layers show broadband single transverse mode fluorescence emission at output powers up to 300 µW and propagation losses comparable to those in unstructured planar waveguide counterparts.

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Rib waveguides based on pulsed-laser-deposited Ti:sapphire thin films have been fabricated by Ar^+ milling. Mode intensity profiles show strong optical confinement (Fig. 1) with measured beam propagation factors M_x^2 and M_y^2 of 1.12 and 1.16 respectively, indicating single-transverse-mode fluorescence emission. Fluorescence output powers up to 300 µW have been observed from the ribs following excitation by a 3W multiline argon laser. The experimental fluorescence output levels for ribs with different size were in satisfactory agreement with theoretical calculations based on a plane wave analysis accounting for ground state depletion (Fig. 2).

Non-destructive propagation loss measurements were performed via the self-pumped phase conjugation (SPPC) technique [1]. The output from a Ti:sapphire laser operating at 720 nm was launched into the rib waveguides and the outcoupled mode was phase conjugated via SPPC from a nominally undoped $BaTiO_3$ crystal. The retro-reflected beam was thereby automatically coupled back into the waveguide without any launch losses other than the Fresnel reflections. By measuring the phase conjugated beam before and after propagation through the guides we evaluated a propagation loss for the rib waveguide of 1.7±0.1 dB/cm. This value is comparable to the background loss level of other PLD grown Ti:sapphire thin films, which were ~1.6-1.8 dB/cm [2], thereby suggesting that the loss level remains essentially unchanged after the rib fabrication process.

The combination of the modal properties and stronger optical confinement compared to bulk samples [3] and planar waveguides [4], together with increased levels of fluorescence output, make the Ti:sapphire rib waveguides a very interesting candidate as a fluorescence source for optical coherence tomography applications.

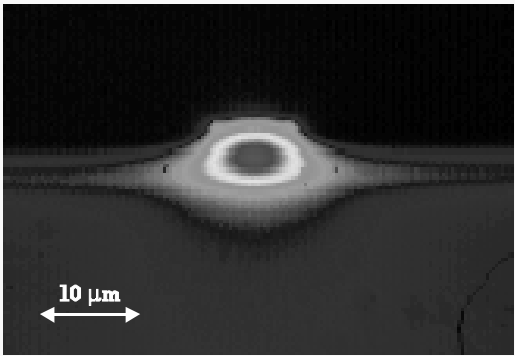

Figure 1: Fluorescence emission profile measured at the exit face of a Ti:sapphire rib waveguide with a depth of 5 µm and a width of 14 µm.

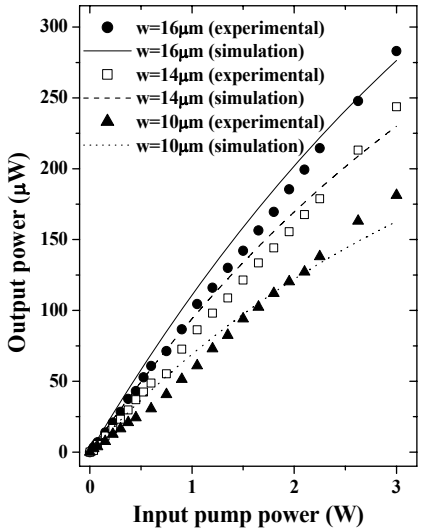

Figure 2: Fluorescence power as a function of pump power from an Ar^+ laser for ribs with a various size.

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