ISLA project newsletter #3

April 2013

ISLA is a project supported by the European Commission under the Seventh Framework Programme (FP7).

Welcome to the third ISLA project newsletter!

The project has reached its halfway point, and the project continues to progress well. In this newsletter we report on further improvements to the optical fibres from ORC Southampton and new PM fused fibre components from G&H. G&H also reports on some exciting progress in its 2 µm isolator development and its high power pump combiners (see below!!).

The ISLA Advisory Group (IAG) has continued to grow, and some important connections have been made with commercial and academic organisations interested in the 2 µm fibre laser technology.

Readers wishing to know more about the project are invited to join the IAG, which offers an opportunity to help direct the development work and to identify and develop new applications for 2 µm fibre lasers with the consortium.

Andrew Robertson (G&H) also runs the 2um and mid-IR lasers group on LinkedIn: new members welcome!

High power 2 µm pump combiners

G&H has fabricated high power 7x1 pump combiners for high power thulium fibre lasers. These components will be used in the ISLA demonstration lasers to combine the high power 79x nm pump diodes from Oclaro.

Due to the intense power levels the thermal management of these fibre-based components needs to be very carefully modelled, and G&H has developed a new package for ISLA. Devices are currently under-going testing at up to 2.1 kW of pump power.

Prototype 7x1 pump combiner from G&H

For more info contact Tom Legg:
tlegg@goochandhousego.com

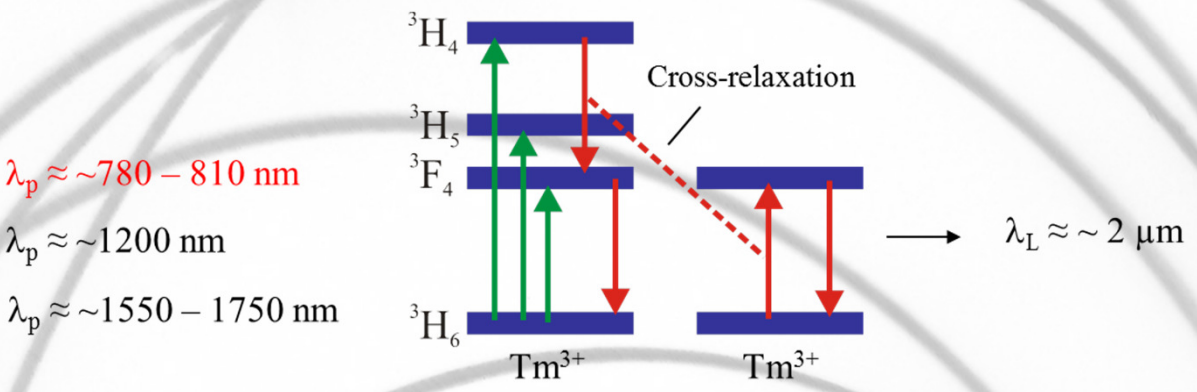
Consortium

Gooch & Housego
TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH
rofin
UNIVERSITY OF Southampton Optoelectronics Research Centre
oclaro
Time-Bandwidth
VIVID COMPONENTS

Coordinator Andrew Robertson arobertson@goochandhousego.com
Admin Bruce Napier bruce@vividcomponents.co.uk

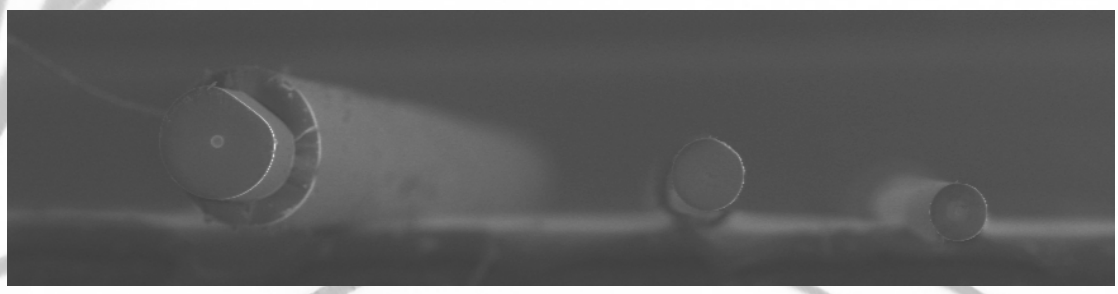
Rare-earth doped Tm and Ho fibres for high power lasers

In the ISLA project Tm fibres pumped at 79x nm and operating at 1950 nm are being developed. All optically pumped laser systems have a fundamental limit on efficiency due to the difference in energy between the pump photons and the output photons, known as the quantum defect. This difference in wavelength is suggestive of a fundamental limit to the optical to optical efficiency of ~40%. Thankfully by tailoring the composition of a Tm-doped fibre it is possible to take advantage of a 'two-for-one' process that allows the emission of two laser photons for only one pump photon doubling the potential quantum efficiency.



Energy level diagram of the Tm ion. Shown is the cross relaxation process between the $^3H_4$ and $^3H_6$ energy levels that can lead to two electrons in the $^3F_4$ upper laser level from a single pump photon of 780-810 nm.

The diagram above shows the energy level diagram of the Tm ion, with highlight on the "two-for-one" cross relaxation process that can allow high efficiency operation of a 2 µm Tm-doped silica fibre laser pumped at ~790 nm. The cross relaxation process is critically dependent on the doping concentration of Tm ions. If the doping level is too low then the cross relaxation process will not occur readily and the laser efficiency will be limited by the quantum defect. If the doping level is too high other non-linear processes can occur, such as up-conversion and excited state absorption.



Scanning electron microscope images of two Tm- and a single Ho-doped fibre (centre) produced at the ORC.

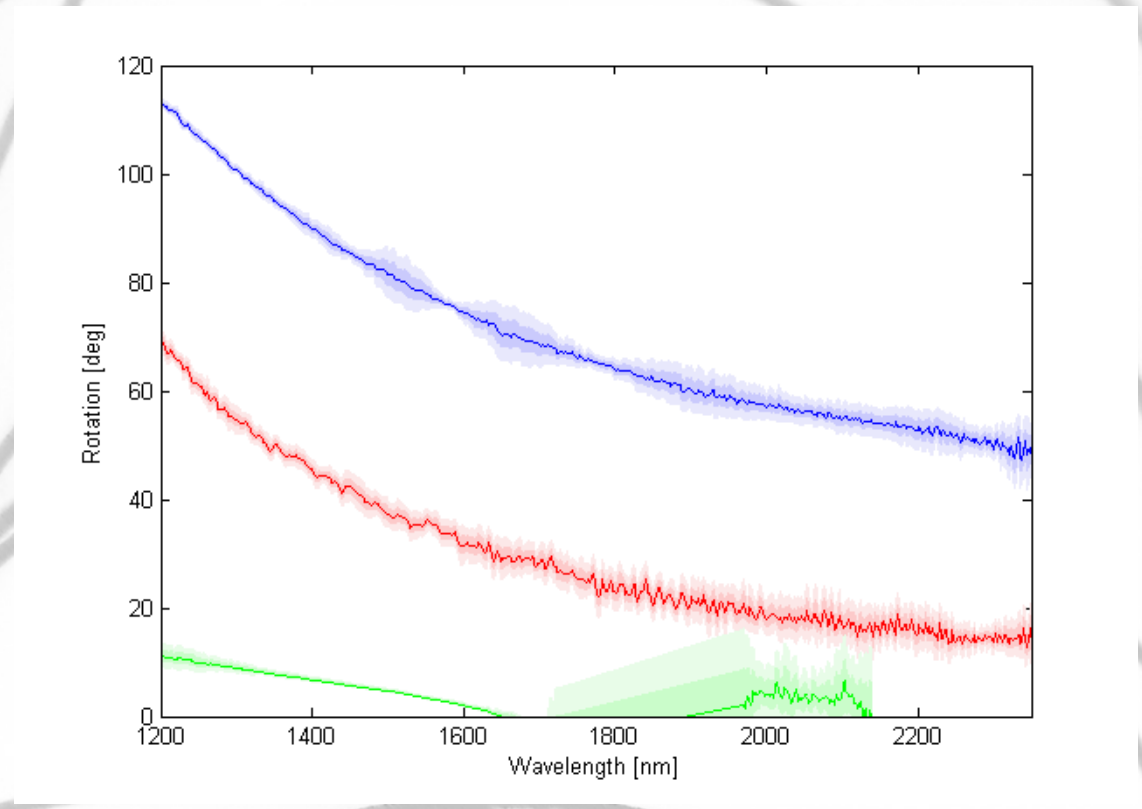
Through minimisation of core propagation loss, via reduction of the OH contamination to 0.1 ppm, and tailoring of the Tm & Al concentration within the fibre, slope efficiencies of 63% with respect to absorbed pump power have been demonstrated. This represents ~1.6 laser photons for each pump photon above threshold, demonstrating efficient operation of the 'two-for-one' cross relaxation process. Further improvements in this efficiency are expected as the preform core composition is further optimised.

For more info contact Peter Shardlow
ps2c11@orc.soton.ac.uk

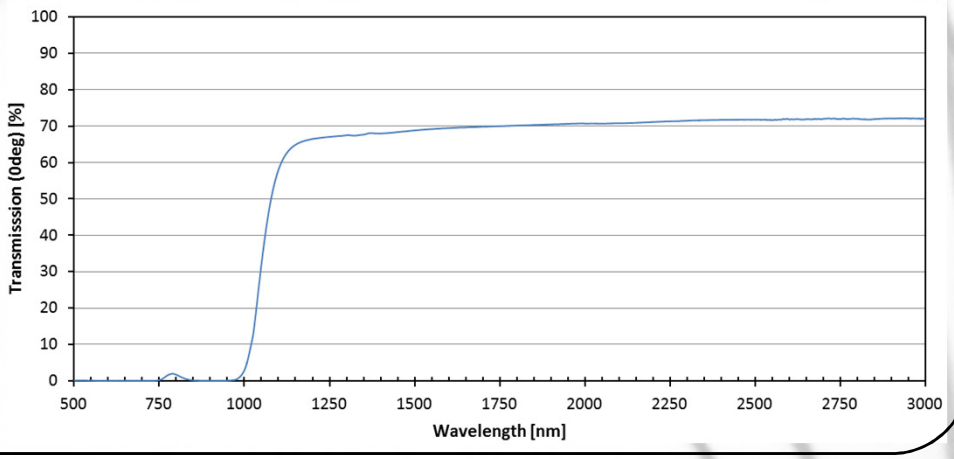
Faraday rotator materials for 2 µm

Most optical isolators utilise the Faraday Effect which is the rotation of the plane of polarisation of a light wave as it propagates through a medium subjected to a magnetic field parallel to the direction of propagation. The Faraday effect is particularly unusual because it is non-reciprocal. Thus if light passes a magneto-optical medium (a Faraday rotator) twice in opposite directions, the Faraday rotation does not cancel, but doubles. This non-reciprocal behaviour gives the basis for optical isolator components which function as one-way optical valves or diodes.

Several potential Faraday rotator materials for 2 µm isolators have been characterised by researchers at G&H. Some of the materials show great promise, producing rotations several times larger than isolator materials commonly used at 1 µm, such as terbium gallium garnet (TGG). As can be seen from the graph below, the new materials offer greatly increased rotation in the two micron spectral region. Furthermore, these materials have also been shown to have high transmission and damage thresholds.



Graph (upper) showing Faraday rotation of three candidate materials. TGG is shown in green, with two new experimental materials in red and blue. A typical transmission curve is shown in the lower graph.



For more info contact Gary Stevens:
gstevens@goochandhousego.com

Fused fibre PM components for 2 µm

Micrograph cross-section through a G&H ISLA PM 2 µm WDM.

Packaged prototype polarisation maintaining (PM) wavelength division multiplexer (WDM) developed through ISLA for 2 µm operation.

Within the ISLA project, G&H has developed its fused PM WDM (polarisation maintaining wavelength division multiplexer) components to include the 2 µm operating window.

The G&H fused PM WDM combines multiple wavelengths of light in PM fibre whilst preserving the polarisation of the transmitted light. G&H proprietary PM manufacturing technology provides low loss, with high polarisation extinction ratio. The all-fibre construction offers excellent reliability and high power handling characteristics. In common with all PM components, it is necessary to launch into either the slow or the fast axis to maintain polarisation.

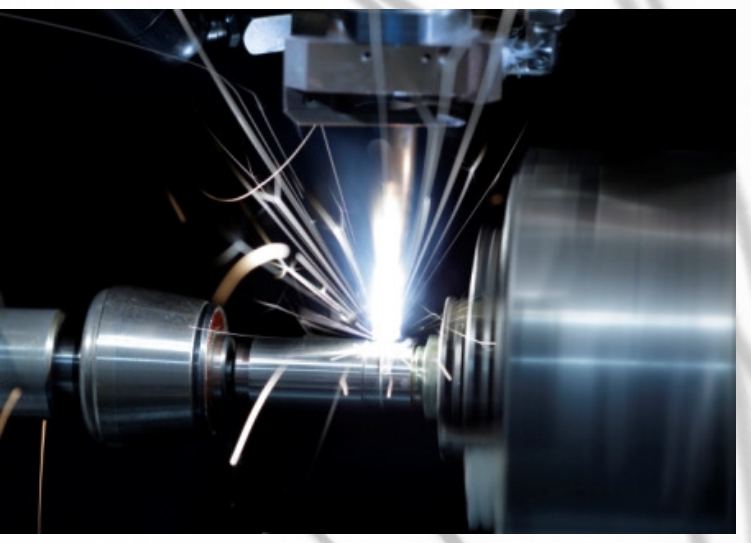
A range of other fused devices has also been developed for 2 µm applications through advances in the ISLA project, including side-coupled power combiners with PM signal feed-through. These devices provide the combination of MM pump fibres with a PM signal feed-through and a PM dual-clad output.

For more info contact Gary Stevens:
gstevens@goochandhousego.com

ISLA Advisory Group

The consortium seeks to build relations with all organisations with an interest in 2 µm fibre lasers. In particular we would like to discuss ISLA with end users and we hope to find novel applications which could take advantage of 2 µm radiation. To date we have over fifty members of the IAG from a wide range of backgrounds:

- Component manufacturers
- Laser/ system integrators
- Academia
- Research organisations
- End users.



Join the IAG!

If you would like to find out more and be involved with the project please contact Bruce Napier bruce@vividcomponents.co.uk