High Power Spectrally-Tailorable Thulium-Doped Fibre Amplified Spontaneous Emission Source

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Thulium doped fibre lasers offer an extremely wide tuning range within the 2µm wavelength band. As such they are of great interest to a wide variety of applications, from spectroscopy and remote sensing, to materials processing and laser surgery. Many of these applications require control of the output spectrum to target specific spectral features whilst simultaneously avoiding unwanted atmospheric absorption lines that will attenuate the power delivered to the item of interest. We report on a power-scalable Tm-doped fibre source architecture that produces a pulsed amplified spontaneous emission (ASE) output with wide flexibility in the shape of the emission spectrum.

The source was based on novel Tm seed source configuration utilising a wavelength-dependent feedback scheme incorporating a Texas Instruments digital micro-mirror device (DMD) followed by a cladding-pumped Tm fibre amplifier. The seed source (shown on the left in Fig.1) utilised an in-house fabricated 0.2wt% Tm doped fibre gain stage with a 10µm diameter core and 0.13NA, core-pumped by a commercial Er,Yb fibre laser source operating at 1565nm. Control of the output spectrum was achieved by using an external feedback arm which comprised an acousto-optic modulator (AOM) from which the first order diffracted beam is passed onto a

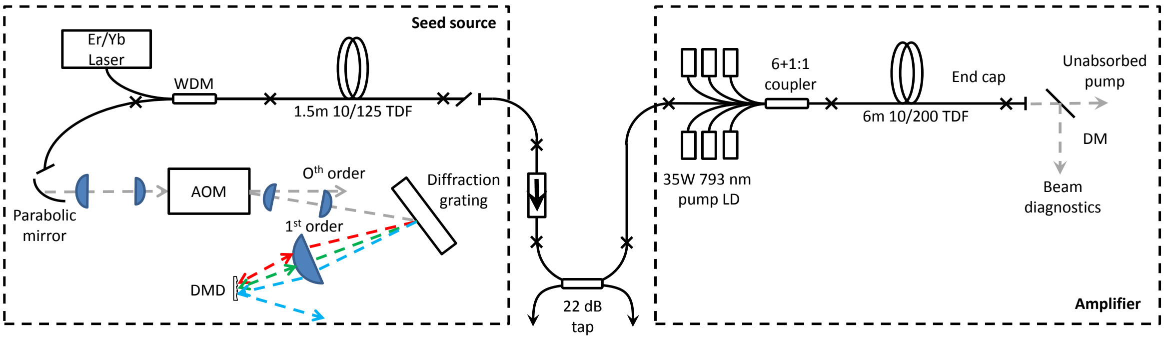

Fig. 1 Schematic of the seed and amplifier stages showing the seed and amplifier blocks.

diffraction grating (600 lines/mm) and then the DMD. The diffraction grating acts to spatially chirp the wavelengths across the DMD face, which in turn by electronic control of the spatial DMD reflection profile allows selection and rejection of individual wavelength bands. The wavelength resolution achievable with this set-up was <0.5nm. The frequency shift that occurs on each pass of the AOM prevents the build-up of longitudinal modes, frustrating lasing. The net result is effectively a spectrally-tailored ASE output spectrum with a high degree of control over the shape [1]. The AOM was operated at a 150kHz repetition rate providing pulsed output down to 200ns duration. The active fibre was terminated with an angle-cleaved face to suppress back reflection with the output coupler formed from the Fresnel reflection from the input face of the passive fibre lead-in to the fibre amplifier (right side in Fig. 1). This arrangement allowed ~80% of the seed output power to be coupled into the fibre lead in. The seed source was passed through an isolator and a 22dB tap coupler to prevent back reflections impacting on the seed and to monitor the seed output. This was fed into a 6+1:1 fibre combiner where preliminary diode pumping of up to 70W at 795nm was coupled into the cladding of passive fibre, which was in turn spliced to a 5m long in-house fabricated 4-wt% Tm fibre with a 10µm diameter core and 190µm flat to flat quasi-octagonal inner-cladding. The latter was terminated with an endcap to suppress parasitic lasing.

In preliminary work, the amplifier yielded 32W of spectrally-tailored output in the ~2µm band from <1W of seed power launched into the amplifier. The amplifier efficiency with respect to absorbed pump power was 62%. Moreover, a maximum pulse energy of ~200µJ was obtained. The performance of the amplifier does, as expected, depend on the seed spectrum and this in turn imposes some constraints on the useful operating band for a given amplifier design. Further details of the operating limits in terms of spectral shape and output power will be presented.

References

[1] A. Billaud, P. C. Shardlow, J. Daniel, W. A. Clarkson, "Spectrally-tailored thulium-doped fibre amplified spontaneous emission source at two microns," 6th EPS-QEOD Europhoton conference, TuP-T1-P-24, (2014)