Mode-locked Fibre Lasers in the Mid-Infrared Region

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In the past decade, innovation has led to the development of new and improved manufacturing techniques for the drawing of soft glass such as ZBLAN and chalcogenide into fibers. This advance has facilitated investigation and experimentation in the mid-infrared region of the electromagnetic spectrum, spanning from about 2 μm to 10 μm, which has traditionally been out of reach for researchers due to the opacity of readily available silica fibres beyond 2 μm. With the addition of erbium doping in high concentrations ($\gg$ 2 mol.%), researchers have been able to use widely available near-IR pump lasers to efficiently generate high intensity laser light at 2.8 μm.

In our work, we aim to combine this ability to generate mid-IR laser light with the well understood behaviour of semiconductor saturable absorber mirrors to achieve *robust* mode-locked operation. The generated train of pulses is then fed into a carefully designed amplifier in order to increase the power and spectral bandwidth simultaneously. The design of this *nonlinear amplifier* is guided by novel numerical modelling techniques which we have developed and tested against experimental results, achieving remarkably good agreement. Thus far, we have demonstrated stable passive modelocking in a linear cavity, as well as nonlinear amplification of the pulse train over a limited range of fibre length and core sizes (see Figure 1).

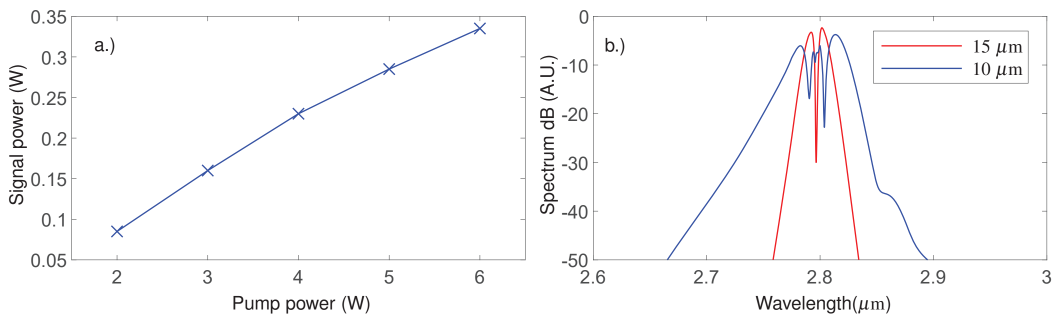

Figure 1: a.) Experimental results for stable mode-locking in a linear cavity formed around 5.2 m of 15 μm core ZBLAN. b.) Simulation of spectral broadening in nonlinear amplifiers for 2.5 m of fiber with core sizes of 15 μm and 10 μm. Erbium doping concentrations are 7 mol.% and 5 mol.% respectively. Signal input of 170 mW and pump power of 8 W