Thulium-doped fiber lasers that lase with wavelengths in the vicinity of 2 µm are useful for several emerging applications including generating mid-IR light via nonlinear frequency conversion. In this study we describe the design and construction of a thulium fiber laser system comprising a master oscillator and a power amplifier. The first stage is a Q-switched, thulium-doped, 95 cm photonic crystal fiber oscillator utilizing an acousto-optic modulator to produce 65-80 nanosecond pulses. A diffraction grating allowed wavelength tunability from 1.837 - 1.964 µm. The oscillator produced up to 3 W of average power and 150 µJ pulse energies, corresponding to 2.3 kW peak powers. The amplifier stage consists of a 130 cm single mode, thulium-doped, step-index fiber seeded with 0 - 2.09 W from the oscillator. An output energy of 750 µJ with 81 ns pulse width, was achieved at a wavelength of 1.9 µm. The effect of the fiber holder temperature on the amplifier performance relative to output pulse energy and seed wavelength. The optimal temperature for long wavelength operation was 15 °C, and 20-24 °C for short wavelength operation.

As a part of this thesis, a methodology has been development to thoroughly characterize Tm:fiber amplifier performance. This has been the subject of prior work by many research groups; however, this work explicitly focuses on precise characterization of absorbed pump power, pump bleaching, and extracted amplified energy for a range of input seeds power, pulse energy, and wavelength.

Major: Electrical Engineering

Educational Career:
Bachelor's of Physics, BS, 2000, Tikrit, Iraq
Master's of Physics / Laser, MS, 2003, Tikrit, Iraq

Committee in Charge:
Martin Richardson, Chair, CREOL/ ECE
Prof Lawrence Shah, Co-Chair, CREOL
Peter Delfyett, CREOL / ECE, UCF

Approved for distribution by Martin Richardson, Committee Chair, on March 18, 2016.

The public is welcome to attend.