All-Fiber 100-ns Single-Frequency 0.5mJ Anisotropic MOPA with Double Clad Tapered Yb-doped Gain Fiber

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High peak power, single-frequency pulsed fiber MOPA sources with extremely narrow line and nanosecond pulses are in highly demand to date. Such sources are required for various applications, including coherent LIDARs systems, remote sensing, and frequency conversion [1]. Stimulated Brillouin scattering (SBS) arising is a main obstacle to further peak power and pulse energy scaling [2].

There are several strategies for SBS suppression in the fiber MOPA have been described in the literature to date. These include exploiting a longitudinal temperature or mechanical stresses gradient in a gain fiber [3] or by using a birefringent fiber with both eigenstates excited. In [4] Stolen has demonstrated doubling of SBS threshold in birefringent fiber with equally excited fast and slow waves. Tapering of a fiber is significantly increases a SBS threshold [5].Usually, authors have used only one of abovementioned strategies for SBS mitigation. Meanwhile, all these measures might be imposed simultaneously by using a short, active, tapered, end pumped (aiming strong temperature gradient) fiber with large mode field diameter fiber.

The experimental set up is shown in Fig.1.

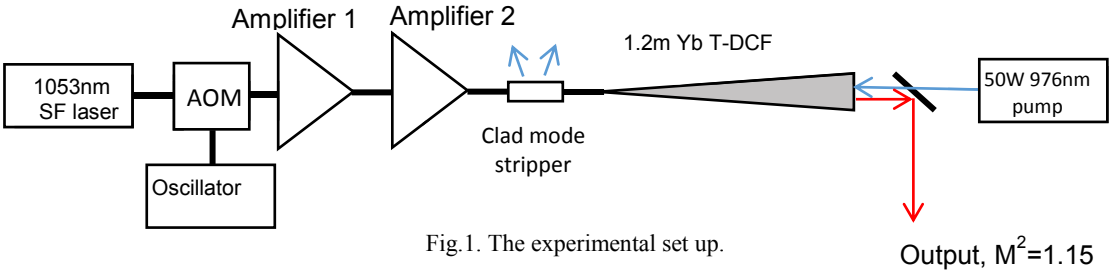

Fig.1. The experimental set up.

The master oscillator consists of a 50mW semiconductor CW DFB laser diode (1053nm FWHM<5 MHz). The radiation from DFB laser launched via PM fiber into acousto-optical modulator (AOM) to get 100ns-long pulses. To avoid pulse shape distortions during amplification we have applied specially shaped pulses [6] from generator of arbitrary shape to AOM. The average power of 100ns pulses (10kHz repetition rate) after the AOM is only 10µW. To get reasonably strong seed signal for saturation of double clad tapered power amplifier the dual stage in-core pumped preamplifier has to be used.After second stage of amplification (amplifier 2) the average power was 30mW. Further, the amplified emission was launched into the narrow side of 1.2m length ytterbium-doped tapered amplifier pumped only from wide side by fiber coupled wavelength stabilized 50W 976nm multimode diode. The ytterbium tapered fiber had 40µm mode field diameter core diameter and 400µm clad diameter at the wide side accordingly, i.e., the tapering ratio was 3.2. Maximum pump power launched into tapered fiber was about 40W.

In conclusion, we have presented short (1.2m), tapered, birefringent, ytterbium doped, end pumped double clad fiber MOPA system with 40µm mode field diameter for amplification of single-frequency long pulses (100ns) for coherent LIDAR application. We have reached record 0.522mJ pulse energy and demonstrated highest to date 5kW peak power by using anisotropic active tapered double clad fiber as a gain media and exciting both slow and fast polarization waves.

References

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