

Narrow linewidth polarizer-free 2.1 μ m Ho-doped fiber laser with 45dB polarization extinction ratio

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Fiber lasers operating at 2 μ m wavelength range have great potential in applications like coherent LIDAR [1] and remote sensing [2]. In particular, the 2.09~2.1 μ m range exhibits low atmosphere attenuation [1]. The 2 μ m region could also be a new window for optical communication in hollow core fibers [3], where narrow linewidth and linearly polarized light is preferred. Efficient 2 μ m range lasing has already been demonstrated with both holmium (Ho) [4] and thulium (Tm) doped fiber lasers [5] reaching 2.2 μ m. However, these lasers cannot directly provide linearly polarized light, and inserting a polarizer in the cavity dramatically reduces the slope efficiency. Also, the widely used linear cavity for long wavelength lasing requires careful selection of the output coupling ratio for optimized lasing at a single wavelength. Here, we report an efficient Ho-doped polarizer-free all-fiber laser with linearly polarized output. Utilizing a broadband fiber loop mirror, the output coupling can be continuously tuned, allowing the optimization of output power while covering the whole Ho and Tm band.

A home-made Tm-doped fiber laser at 1950nm, with a maximum output power of approximately 2.3W is used as the pump laser. The laser cavity is sketched in Fig.1 (a). A fiber Bragg grating (FBG) fabricated on PM1950 with reflection of 95.85%, 0.175nm linewidth is used as a high reflection (HR) mirror. The center wavelength on fast and slow axis is 2100.4nm 2100.8nm, respectively. An in-line polarization controller (PC) is connected right after the HR FBG for polarization selection/switching. A SMF-28 pigtail is spliced on 1.9m of Ho-doped fiber for core pumping. A broadband (1.8~2.2 μ m) 75/25 optical coupler is connected as a loop mirror for out-coupling. Another in-line PC is used for tuning the loop mirror reflection/transmission. In Fig.1 (b), the spectrum covering both Tm and Ho emission bands is shown, indicating good noise suppression, high pump absorption and a proper selection of Ho-doped fiber length.

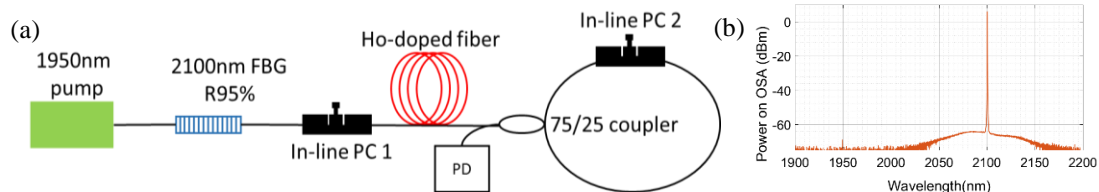


Fig. 1 (a) Laser cavity setup; (b) Laser output spectrum recorded under 0.5nm

The reflection tuning range of the loop mirror is found to be 0~70% measured with a 2 μ m semiconductor laser. The small discrepancy from the theoretical value of 75% is due to the insertion loss from PC2 and coupler, meaning it is less than 0.6dB. By tuning the PC1, the lasing wavelength can switch between the fast- and slow-axis of the FBG while maintaining the same lasing power, as indicated in Fig.2 (a). At the maximum output power of 26.4dBm, the laser linewidth is measured to be less than 50pm on both lasing axis. A slope efficiency of 30% is calculated for a lasing threshold of 580mW (Fig.2 (b)). We monitored the output polarization by sending the laser through a PC and polarization beam splitter placed out of the cavity. Fig.2 (c) shows a stable polarization extinction ratio of 46dB and steady output power.

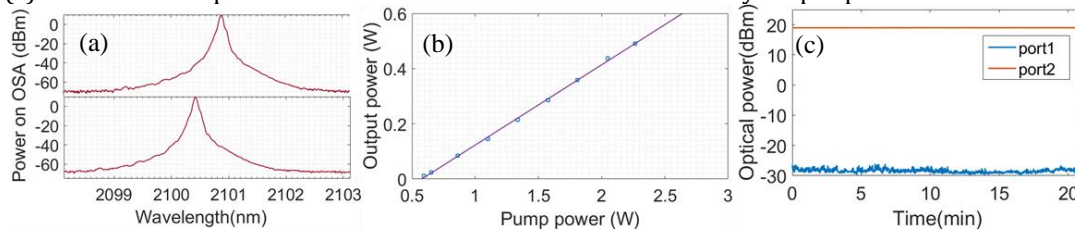


Fig. 1 (a) Laser output switched between two polarization axes; (b) Output power with respect to the 1950nm pump power; (c) Laser polarization extinct ratio monitored over 20min

We demonstrated a high efficiency all-fiber 2.1 μ m laser with linearly polarized output. Also, loop mirror as output can provide both power and linewidth tuning of the laser. The efficiency can be further improved by splicing all the devices. Laser wavelength can be tuned by stretching the FBG and optimized with in-line PC2.

References

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