20 W monolithic erbium fluoride fiber laser at 2.8 μm

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***Abstract*—We report the demonstration of a 2825 nm splice-less erbium-doped fluoride fiber laser delivering 20 W of output power in continuous wave operation. This result represents the highest mid-IR output power obtained from a splice-less laser cavity.**

Keywords – erbium fluoride fiber lasers, fiber Bragg gratings

Fiber lasers emitting near 3 μm have made significant progress in recent years [1,2] and are now good candidates for many applications such as laser surgery, spectroscopy and countermeasures [3]. Emission near 3 μm can be efficiently generated in highly-doped erbium fluoride glasses using the $^4I_{11/2} \rightarrow {}^4I_{13/2}$ transition. However, monolithic splice-less fiber lasers based on heavily erbium-doped fluoride fibers are power limited due to high pump absorption and poor thermal properties of fluoride fibers. Therefore, intracavity components such as splices and fiber Bragg gratings (FBGs) require proper thermal management. In most high power demonstrations of 3 μm-class fiber lasers [4], the highly reflective FBG is written in the core of an undoped mode matching fiber to reduce its heating and prevent it from shifting outside the reflective band of the low reflectivity output FBG. However, splicing of single-mode fluoride fibers is a challenging process and it increases the round-trip losses of the cavity.

In this work, we present a splice-less passively cooled erbium fluoride fiber laser cavity at 2825 nm. The laser assembling was simplified by eliminating all intracavity splices and by writing both FBGs in the core of the gain fiber.

The experimental setup of the laser is shown in Fig. 1. An erbium-doped zirconium fluoride double-clad fiber (6.5 m, 7 mol. %, 15/260 μm, 0.12 NA) is used as the gain medium.

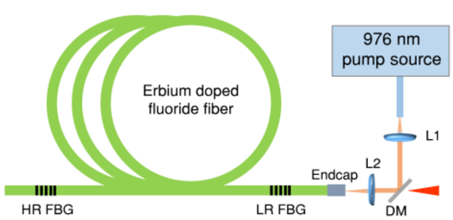

Fig. 1. Experimental setup of the laser (HR-FBG, highly reflective grating (R=99%); LR-FBG, lowly reflective grating (R=5%); DM, dichroic mirror; L1, L2, coupling lenses).

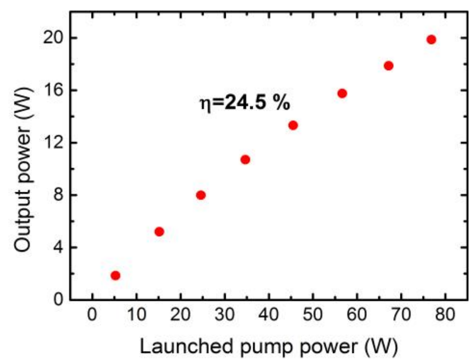

Fig. 2 Output power as a function of the launched pump power.

Both FBGs are written directly in the core of the erbium-doped fluoride fiber. The output fiber tip was capped with a short segment of coreless AlF_3 fiber (length of 500 μm) in order to slow down the OH diffusion in the fiber core. The cavity fiber and its FBGs are passively cooled on an aluminum spool. To limit the heating of the HR-FBG, the cavity is backward pumped by a 980 nm pump source (120W, 0.22 NA, 220/240 μm) with a launching efficiency of 65%. An output power of 19.8 W at 2825 nm and a 24.5 % slope efficiency with respect to launched pump power is obtained. Figure 2 shows the output power as a function of launched pump power. Compared to previous splice-less cavity demonstrations, a fourfold increase in output power is obtained [5,6].

In conclusion, an erbium-doped splice-less monolithic cavity delivering a maximum output of 19.8 W at 2825 nm was demonstrated; the highest output from a mid-infrared fiber laser cavity without intracavity splices. The power scaling potential of cavity will be discussed in this presentation.

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