Q-switched all-fiber Ytterbium laser with an integrated polarization switch

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Q-switching is a well-known method to obtain short duration and high energy pulses from fiber lasers. However, most of the active switches used are bulk devices, mainly acoustooptic [1], and electrooptic modulators. Therefore, the integrability and the compactness of the whole Q-switched fiber laser is limited. Here we demonstrate an all-fiber laser operating at 1-µm wavelength, Q-switched with a short risetime (~20 ns) fiber polarization switch (PS). This component is described in more detail in earlier work [2]. The device is based on a microstructured fiber, single mode at 1.5 µm, containing four electrodes running parallel to the core, as illustrated in Fig. 1(a). Application of a short high voltage (HV) pulse to one of these electrodes makes the metal expand rapidly and causes uniform mechanical stress to the core. This stress induces birefringence, which rotates the polarization of the guided light in nanoseconds, i.e. switching the component ON. At room temperature, the switch relaxes on a 200 µs scale. However, by applying a HV pulse to a second electrode, the birefringence can be counteracted in nanoseconds and the polarization rotated back, i.e. switching the component OFF.

![Fig. 1](image1)

Fig. 1 (a) Cross section of the polarization switch and (b) schematic of the ring-cavity

The cavity, displayed in Fig. 1(b), consists of a 500 mW / 976 nm pump injected through a polarization maintaining (PM) multiplexer, a PM Ytterbium-doped fiber used as amplifier at 1.03 µm, a 90% PM output coupler, and the PS in combination with a polarizing PM isolator. Polarization controllers (PC) are employed before and after the PS in order to achieve proper switching and to inhibit lasing when the component is OFF.

At 2 kHz, the laser delivers pulses of ~150 ns duration as seen in Fig. 2(a). The maximum average output power is 26 mW at the highest pump power available. This corresponds to a pulse energy 13 µJ and peak power close to 90 W. Since the risetime of the PS, is roughly half the cavity roundtrip time, gain saturation causes peaks within the envelope of the output pulse. In this case the component switches ON with a short risetime but relaxes naturally. However if fast switching OFF is also employed the tail of the pulse can be cut, cf. Fig. 2(b).

![Fig. 2](image2)

Fig. 2 (a) Optical output pulse at 2 kHz and 360 mW pump. (b) Optical output pulse at 2 kHz and 440 mW pump, delay between switching ON and OFF is 170 ns.

References