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The features of sine operation regime in moderately erbium doped fiber lasers

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The paper presents the results of an experimental study of the moderately erbium doped fiber lasers with short resonators operation features. Operation regimes in the case of 976 nm wavelength pump have been investigated. The dependence of the parameters and regimes of operation on the cavity length and pump power, namely the transition from pulsed to CW lasing, is investigated.

The operation features study of single-frequency erbium fiber lasers of the 1.5 μm optical range is necessary to control and reduce the lasing linewidth which is required in modern fiber optics, allows them to be used for optical sensors, optical communication lines and spectroscopy.

The erbium doped fiber used in our work was made from a preform with a moderate concentration of erbium in the core (absorption at 1530 nm wavelength ≈ 17 dB/m, ≈ 0.03 mol.% Er_2O_3). Based on this fiber three erbium lasers were fabricated according to the classical Fabry-Perot scheme with two Bragg gratings (FP-EDFL) with a cavity length of 28 mm (Bragg gratings were inscribed using femtosecond point-by-point technology), 60 mm and 170 mm (Bragg gratings were inscribed by the UV technique by the radiation of an excimer ArF laser). The lasing wavelength of fiber lasers was determined by the period of the Bragg gratings and ranged from 1539 to 1551 nm.

The laser operation regime at low pump power corresponds to passive Q-switching, and when the pump power increases the operation switched to CW with sine modulation. The dependence of the pulse frequency and sine modulation on the cavity length and pump power at room temperature is established. The formation of a pulsed operation regime is characteristic of erbium heavily doped lasers due to accelerated depopulation of the excited erbium level in sight of the up-conversion at the lasing wavelength. Up-conversion proceeds most effectively when pairs of erbium ions (mini-clusters) are formed in the active fiber [1, 2]. The switching between pulsed and CW regimes at room temperature is achieved by reducing the doping level of the active fiber and increasing the pumping power, which together reduces the proportion of up-conversion in the process of the excited erbium level release [3,4].

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