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Raman fiber laser based on a 7-core fiber with fs-inscribed regular and random structures

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The significant progress in the development of multi-core fibers (MCFs) and the technology of refractive index change by fs- laser radiation [1] in the selective cores of MCF open up possibilities for the creation of new configurations of fiber lasers based on both active MCFs with inscribed fiber Bragg gratings [2] and passive MCFs in Raman lasers with random distributed feedback [3] for high-power laser applications.

In this work, we present the results of Raman fiber laser based on a 7-core fiber with coupled cores operating at 1090 nm pumped into central core by Yb-doped fiber laser at 1050 nm. The laser resonator is formed by highly reflective FBGs (> 90%) inscribed in the side cores of MCF used as the rear reflecting mirror and an array of highly reflective FBGs with a random displacement (5-10 mm) between them in the longitudinal direction with the most of power out-coupled trough the FBG-free central core. We also investigated a laser configuration with an additional fs-inscribed random structure of the refractive index in the central core of MCF provided a reflectance significantly higher (> 50 dB) than the Rayleigh backscattering level.

The generation of single peak of 20 pm linewidth (corresponding to OSA resolution) near the threshold was observed in both cases. At output power of 0.4 -1.5 W (from one fiber end), the laser linewidth (FWHM) is reduced by ~2 times in the case of laser cavity with random distributed feedback (RDFB) structure in central core of MCF (fig 1a, b). At Stokes output power of 2.25 W, the difference between the linewidth became less - about 50 pm, the FWHMs corresponded to 250 pm and 300 pm, respectively (fig. 1c).

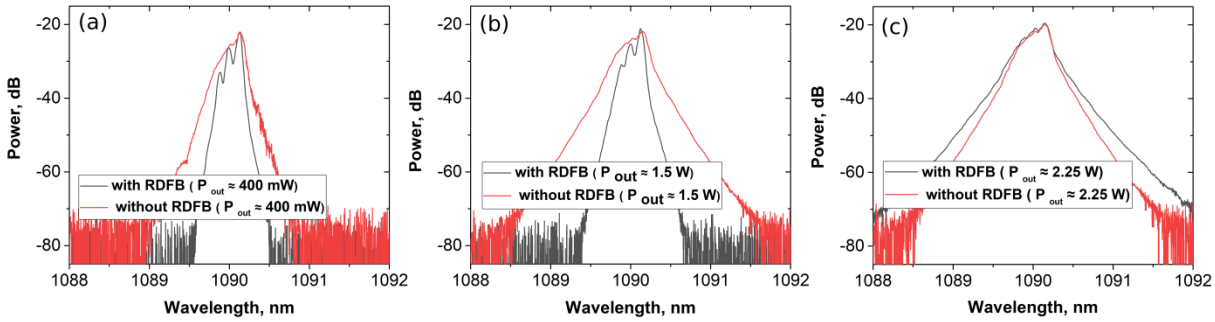

Fig. 1 The spectrum of Raman fiber laser with (black line) and without (red line) fs-inscribed random structure of the refractive index at different output power: a) 400 mW, b) 1.5 W, c) 2.25 W.

Thus, we observe sufficient narrowing of the linewidth for MCF based Raman laser as compared to the random Raman lasers based on single- and twin- core fibers [4] that may be explained both by a decrease in the influence of nonlinear effects due to an increase of the effective mode field area in 7-core fiber and by the effect of spectral filtering of a fiber interferometer formed in a mode-coupled MCF by the FBG array with random axial displacements.

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