Single-Frequency Er-Doped Fiber Laser Based on Random Distributed Feedback Implemented on Irregularities of Phase Mask

M I Skvortsov[1], S A Abdullina[1], and A A Vlasov[1]

[1]*fiber optics lab, Institute of Automation and Electrometry SB RAS, 1 Academician Koptyug ave., Novosibirsk, Russia. Contact Phone: +79833149387*

Contact Email: qwertymikhails@gmail.com

Distributed feedback (DFB) fiber lasers are known as a versatile source of single-frequency radiation for a wide variety of applications, from high-resolution spectroscopy to precision sensing, thanks to the high stability, low noise level, and narrow linewidth.

The cavities of such lasers are formed by a fiber Bragg grating (FBG) with a phase shift of a quarter of the generation wavelength in the central part, which ensures the selection of one longitudinal mode. These structures are fabricated in photosensitive fibers using ultraviolet (UV) radiation and a phase mask [1] or using a point-by-point femtosecond (fs) technique [2]. The implementation of an accurate phase shift for both methods implies the use of additional equipment in the form of piezoceramic elements, which complicates the process fabrication of the structure.

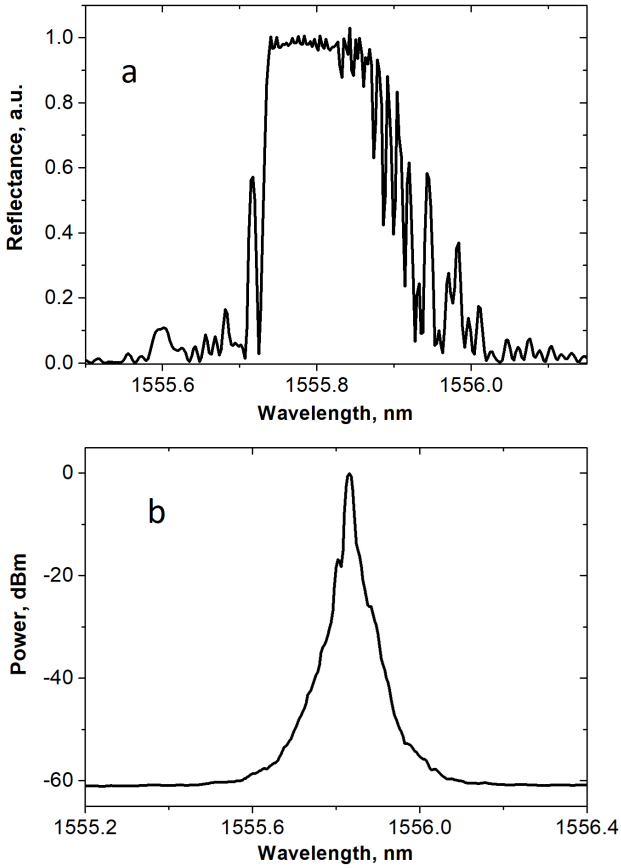

Figure 1: (a) Reflection spectrum of a 6-cm highly reflective FBG fabricated in erbium fiber; b – optical generation spectrum of a random laser at maximum output power

It was shown in [3] that the influence of technological defects or small deviations of periodicity in the structure of the phase mask at large lengths inevitably leads to a deterioration in the quality of inscribed Bragg gratings. In particular, asymmetric side lobes in the reflection spectrum, which, at a high reflectivity FBG, lead to the generation of these artefacts. At the lasing threshold at a wavelength of 1555.8 nm, the pump power was 10 mW. The output power corresponds to 0.75 mW at a pump power of 540 mW. A single-frequency lasing regime was observed over the entire pump range; the spectral linewidth at the maximum output power corresponds to 1 kHz. Thus, the power and spectral characteristics of a random laser implemented due to deviations of periodicity in the phase mask structure are comparable with the characteristics of a regular DFB laser [4].

We will report on the details of the experiments, and discuss the potential applications of such laser sources.

Acknowledgements: The work was supported by the state budget of the institute of Automation and Electrometry SB RAS (project no. 121030500067-5).

References

[1] S A Babin, D V Churkin, A E Ismagulov, S I Kablukov, and M A Nikulin, Laser Phys. Lett. **4**, 428 (2007)

[2] A Wolf, A Dostovalov, M Skvortsov, K Raspopin, A Parygin and Sbabin, Opt. Laser Technol. **101**, 202 (2018)

[3] S Theriault, F Bilodeau, B Malo, D C Johnson, J Albert, K O Hill and L E Erickson, LEOS '95, IEEE Lasers and Electro-Optics Society 1995 Annual Meeting, 8th Annual Meeting, Conference Proceedings, 1995, pp. 77-78 vol. 2

[4] M I Skvortsov, A A Wolf, A A Vlasov *et al.*, Sci Rep. **10**, 14487 (2020)