Suppression of Brillouin Scattering in Large Mode Area Passive Fibers

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Stimulated Brillouin scattering (SBS) is the major factor that limits maximum peak power of single-frequency pulsed fiber laser systems. It should be noted that in the all-fiber format it is the passive fibers at the amplifier output (used as pigtails in isolator and etc) are those component that often has the smallest SBS threshold [1]. Thus, development of large mode area (LMA) passive fibers with increased SBS threshold becomes an important task. One of the successful approaches is tailoring acoustic profile of the fiber to “push” out of the core acoustic wave and reduce its overlap with optic fields [2]. This approach requires doped outer cladding [3] or a very short wavelength cut-off [4], which is hardly compatible with passive LMA fibers.

In this work we proposed and tested a new approach based on variation of the glass composition along the core radius. In this case different acoustic modes have different SBS frequency shift, thus SBS gain spectra is widening and SBS maximum gain is decreasing. We have designed and fabricated fiber with continuous change of concentration of Al_2O_3, GeO_2 and F in the core as shown in figure 1(a). The core refractive index was step-like, similar to commercially available 20/125 μm fibers. The fiber has mode field diameter (MFD) of 18.0 μm. Additional fibers with outer diameters 100, 110 and 150 μm were drawn from the same preform (MFD = 16.3, 16.9 and 20.0 μm respectively). We compared our fibers to a Ge-doped 20/125 μm fiber with MFD of 20.4 μm.

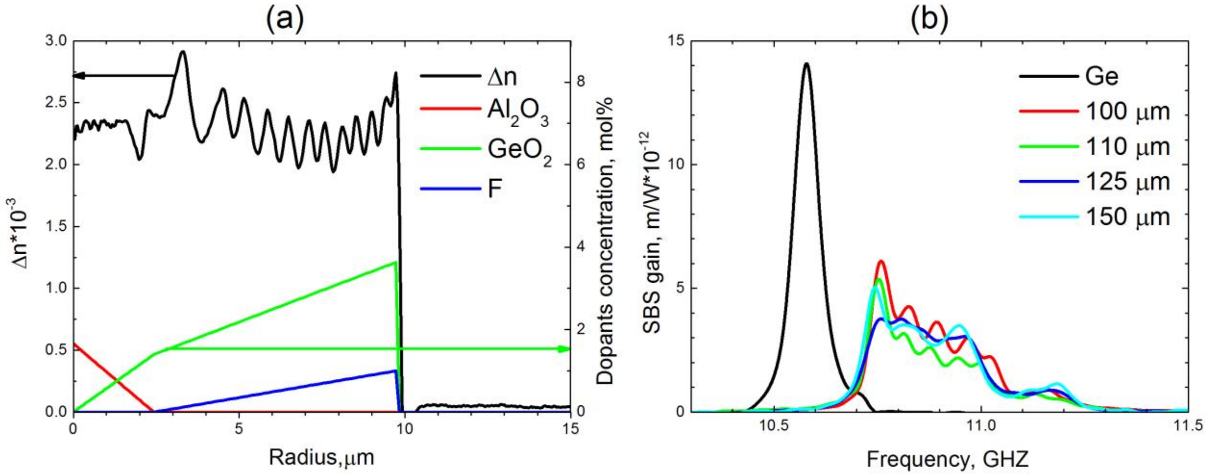

Fig 1 (a), measured optical and designed doping profiles for the fiber with outer diameter of 125 μm; **(b),** measured SBS spectra

The SBS gain spectrum of each fiber was measured using pump-probe technique described in [4]. Results are shown in figure 1(b). Produced fibers have multiple peaks: 5-6 peaks in the area of 10.6 – 11GHz and 1-2 significantly smaller peaks in the area of 11.1-11.3GHz. It is completely different to the Ge-doped 20/125 μm fiber. According to the spectral measurements we obtained suppression by 5.7 dB for the fiber with outer diameter of 125 μm. SBS threshold power was also measured by launching 80 ns pulses of up-to 1 kW of peak power into the test fibers. The threshold was defined by observing pulse instability caused by SBS. Measured threshold powers for one meter of test fiber were 685, 790 W for fibers with outer diameter of 125 and 150 μm correspondingly and 290 W for the Ge-doped fiber. From that we obtained suppression by 4.81 dB.

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References

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