Strain and temperature discrimination using heavily-GeO_2-doped-core optical fibers

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Abstract: We experimentally demonstrate that heavily-doped Germania-core optical fibers, up to 98% mol, could advantageously be exploited to discriminate the effects of strain and temperature in distributed Brillouin fiber sensors.

Stimulated Brillouin scattering (SBS) has been exploited for many years in numerous optical fiber-based devices such as fiber lasers, microwave photonics and optical fiber sensors [1,2]. The latter application has significantly grown in recent years due to the high sensitivity of the Brillouin gain spectrum (BGS) on both strain and temperature. However, because of a linear combination of both temperature and strain applied due to the BGS changes, their discrimination still remains a great challenge [3]. Among the wide range of optical fibers available for sensing, Germania-doped-core optical fibers appear as very attractive candidates due to their high Brillouin gain [4].

In this paper, we demonstrate the advantage of using those highly nonlinear fibers to discriminate the effect of strain and temperature. We show in particular that, for an ultra-high concentration up to 98-mol %, the temperature dependence of the BGS becomes almost negligible (C_T=0.07 MHz/°C), while its strain coefficient remains significant (21.4 kHz/με) compared to that of standard single-mode fibers (48.9 kHz/με). The experimental measurements are shown in Fig. 1 for different tensile strains (left) and temperatures (right). Our findings demonstrate the potential application of heavily Germania-doped-core silica fibers for Brillouin fiber sensors.

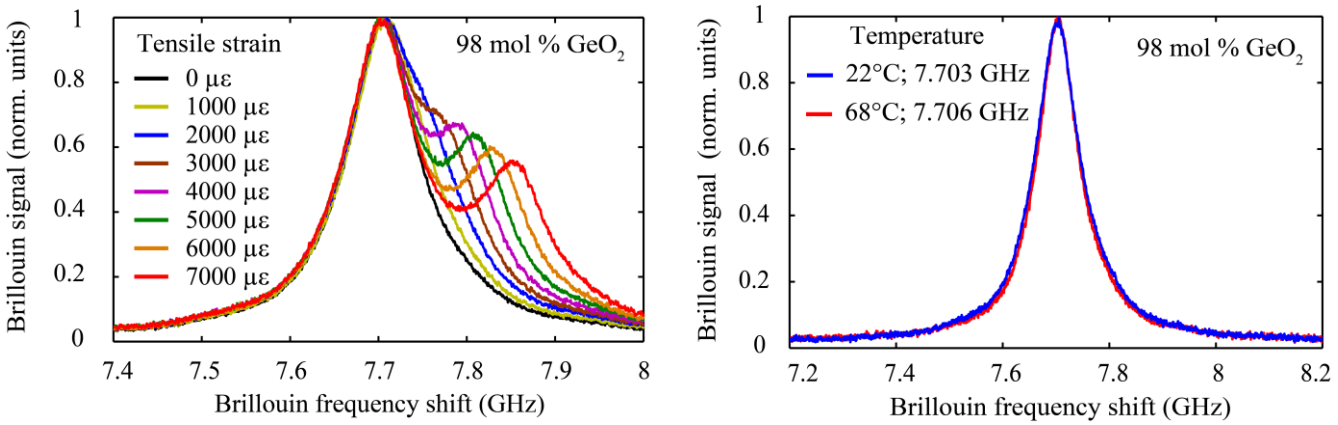

Fig. 1. Experimental backscattering Brillouin spectra measured in a 98-mol %-GeO_2 doped -core optical fiber under different tensile strains (left) and temperature changes (right).

References

1. A. Kobyakov, M. Sauer, and D. Chowdhury, "Stimulated Brillouin scattering in optical fibers," Adv. Opt. Photonics 2(1), 1–59 (2010).
2. C. A. Galindez-Jamioy and J. M. Lopez-Higuera, "Brillouin distributed fiber sensors: an overview and applications," J. Sens. 204121, (2012).
3. T. R. Parker, M. Farhadiroushan, V. A. Handerek, and A. J. Rogers, "Temperature and strain dependence of the power level and frequency of spontaneous Brillouin scattering in optical fibers," Opt. Lett. 22(11), 787–789 (1997).
4. M. Deroh, B. Kibler, H. Maillotte, T. Sylvestre, and J.-C. Beugnot, "Large Brillouin gain in Germania-doped core optical fibers up to a 98 mol% doping level," Opt. Lett. **43**, 4005-4008 (2018).