Brillouin liquid point fiber sensor based on tapered silica optical fiber

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Abstract: We experimentally demonstrate a sensibility of liquid outside tapered silica optical fiber with backscattering Brillouin phenomenon. Mechanical properties of liquid outside fiber can be evaluated.

Recently forward Brillouin scattering has been used to sense different liquid outside standard optical fiber [1,2]. It has been reported that attenuation of shear waves in forward Brillouin scattering is related to interface between fiber cladding and external environment. Backward configuration is very efficient because elastic compression waves involved in Brillouin scattering process are collinear to optical waves. Recently, Bermini *et al.* demonstrates the impact of different liquids on stimulated Brillouin scattering using side-polished optical fibers [3]. In tapered optical fibers, the evanescent field extends all around the fiber and offers a more efficient interaction with the external environment and therefore a higher sensitivity. In this work, we demonstrate for the first time the impact of liquid cladding on backscattering Brillouin spectrum with tapered silica optical fiber.

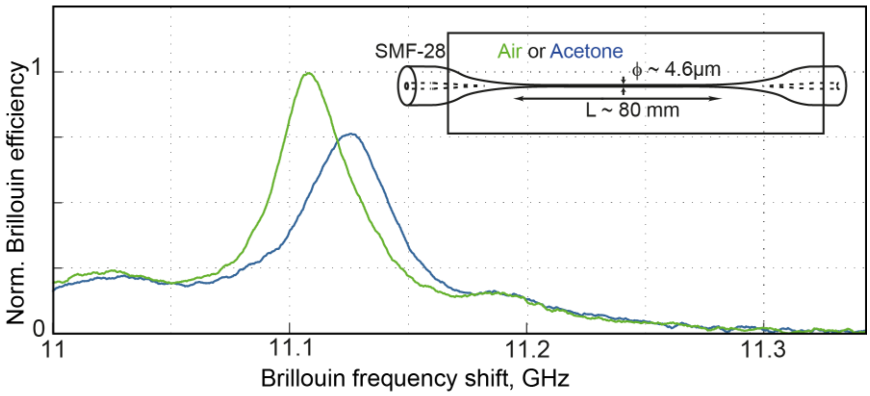

Fig. 1: Backscattering Brillouin spectra for tapered optical fiber surrounding by air (green) and acetone (blue). Both measurement are obtain with the same experimental configuration with a pump wavelength at1550nm. The inset shows the geometrical properties of (TOF).

The diameter of tapered optical fiber (4.6µm) is evaluated by analysing the disappearances of high orders optical modes in the spectrum of transmission signal. A strain of 2% is applied on sample to differentiate the Brillouin spectrum from TOF to SMF (Fig1). Brillouin spectrum measurement are realized at telecom wavelength with refractive index lower than silica to maintain optical guidance. We observe a Brillouin frequency shift of 14 MHz when air is replaced by acetone as depicted in Fig1. The frequency shift and the reduction of efficiency are directly related to the variation of optical effective index. Contrary to classical measurement of refractive index variation induced by liquid in TOF [4], the variation of Brillouin efficiency and the Brillouin linewidth can be used to determinate the mechanical properties of surrounding liquid.

References

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