Opto-mechanics of tapered optical fibers

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Abstract: We review our recent works on Brillouin light scattering in tapered optical fibers, from the observation of surface Rayleigh waves, to the precise measurement of taper diameter and the effect of nonlinear elasticity.

Subwavelength-diameter optical fibers, also known as optical nanofibers, are the tiny cousins of standard optical fibers [1–3]. These hair-like slivers of glass, manufactured by tapering optical fibers down to a size hundred times smaller than a strand of hair, have a number of optical and mechanical properties that make them very attractive for many applications such as optical sensing [2], atom trapping and quantum optics [4, 5], nonlinear optics [6, 7], evanescent coupling, optical filtering [8], and plasmonics [9]. In addition to providing new optical properties, optical nanofibers also possess unique acoustic properties that make them interesting for exploiting the Brillouin light scattering.

In this talk, we'll review our recent results on this photon-phonon interaction in tapered fibers as well as in solid-core photonic crystal fibers (PCFs) [10–13]. These include the observation of surface (SAW) and hybrid (HAW) acoustic waves with anti-crossings [10], the Brillouin frequency tuning and linewidth broadening in chalcogenide-glass optical microfibers [11]. Surface Brillouin scattering will be also reported in small-core PCFs with high air-filling fraction [12]. We will further describe a simple and accurate technique for precise measurement of fiber taper diameter and uniformity [13]. The method is based on a direct and fast numerical analysis of the backward Brillouin spectrum. It can be performed *in situ* without any manipulation nor optical alignment of optical nanofibers. Sensitivity as high as a few nanometers for fiber diameter ranging from 500 nm to 1.2 μm can be achieved, which is comparable to scanning electron microscope. This method could help for the design and characterization of micro and nanoscale photonic chip platforms used in many applications. Finally, we will show last results about tensile-strain measurements of tapered fibers, including the effect of nonlinear elasticity.

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