Diameter and Tensile Strain Measurements of Optical Nanofibers using Brillouin Reflectometry

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Optical microfibers and nanofibers, manufactured by tapering standard optical fibers down to a few hundred nanometers, are being widely used in many applications ranging from quantum and ultra-cold atom optics to optical sensing [1]. Recently, there has been increased interest in developing simple methods to accurately measure their optical, geometrical, and mechanical properties [2].

Here, we describe a new technique that allows for a complete experimental characterization of optical microfibers and nanofibers. Our method is based on a direct and fast analysis of the Brillouin backscattering using a highly sensitive heterodyne coherent detection. Our experimental results show several Brillouin resonances from surface acoustic waves (SAWs) and hybrid acoustic waves (HAWs) that are very sensitive to the nanofiber waist and taper transitions [3]. A detailed analysis of these resonances was performed and sensitivity as high as a few nanometers for fiber diameters ranging from 500 nm to 1.2 µm is reported. The technique can be performed *in situ* without any manipulation or optical alignment of optical nanofibers.

We further investigate the elasticity of optical nanofibers under tensile strain up to 7% of elongation which is 3 times largerthan standard telecom fiber (2%).For nanofiber waist diameters ranging from 710 nm to 2 µm, we measured strain coefficients ranging from 150MHz/% for SAWs up to 450MHz/% for HAWs, respectively. Our experimental data are checked against a nonlinear elastic-strain model including the variation of both the shear and longitudinal acoustic velocities through the elastic coefficients [4]. A quite good agreement of the strain dependence of all Brillouin frequency shifts for several microfiber diameters is found.

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