Observation of Brillouin backscattering in a 50cm-long high-index doped silica chip waveguide

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Brillouin scattering (BS), whereby light interacts coherently with hypersonic acoustic waves, is a powerful and flexible optical effect for processing light and microwave, making optical sensors, frequency combs, and lasers. While BS has been early exploited in optical fibers, it is only recently that it has been demonstrated in CMOS-compatible integrated waveguides based on chalcogenide (ChG), silicon (Si), or silicon nitride (SiN) in its stoichiometric composition (Si_3N_4) [1-4].

Here we demonstrate on-chip Brillouin backscattering in a 50-cm long spiral high-index doped silica glass integrated waveguide [5]. The waveguide cross section structure is shown in Fig. 1(a), including a high index (n=1.7) doped silica core embedded in SiO_2 on a thermal oxide and a silicon wafer. The core has a cross-section of 1.5µm by 1.52µm and the total insertion loss of the long spiral waveguide has been measured as 8.9 dB at λ=1550 nm using a high-resolution optical time domain reflectometer (OBR Luna Tech.). The Brillouin spectrum has been measured using a simple heterodyne technique [6], whereby the backscattered Brillouin signal coherently interferes with a local oscillator and is further detected using an electrical spectrum analyser (ESA). The experimental Brillouin spectrum is shown in Fig. 1 (b) for an input c.w. power of 18 dBm at 1550 nm. The measured Brillouin shift and its full-width at half-maximum (FWHM) linewidth were ν_B=16 GHz and $\Delta\nu_B$~200 MHz, respectively. This gives an acoustic velocity of $V_L = \nu_B \lambda/(2n_{\text{eff}})$ =7700 m.s^{-1}, with n_{eff}=1.61 the effective index of the fundamental optical mode. This is in good agreement with theoretical prediction and numerical simulation shown in Fig. 1(c), where we plotted the numerically computed Brillouin spectrum from the elastodynamic equation including electrostriction [6] (kinetic energy density versus the acoustic frequency). The insets in Fig. 1(c) show the computed optical (top) and acoustic (bottom) transverse intensity profiles, respectively.

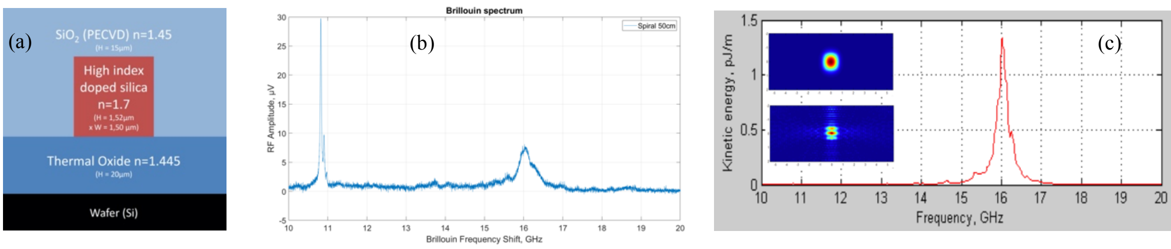

Fig. 1 (a) High-index doped silica chip waveguide cross section structure used for Brillouin observation. (b) Experimental Brillouin spectrum, measured for an input power of 18 dBm at 1550 nm, showing the Brillouin peaks at 16 GHz of the high-index chip, and at 11 GHz due to silica fibers in the setup. (c) Numerical simulation of the Brillouin spectrum (kinetic energy density versus acoustic frequency). The insets show the optical (top) and acoustic (bottom) modes.

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