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Abstract: *We provide a new pump-probe method to accurately measure the Brillouin gain in the radio-frequency domain and we use it to measure the backward gain in silica optical nanofibers for the first time. A stimulated gain as high as* g_B*=11.3* $W^{-1}m^{-1}$ *for the L02 acoustic mode at 8.6 GHz was achieved, which is 50 times larger than a standard fiber. We also report a high Brillouin gain up to 5* $W^{-1}m^{-1}$ *using surface acoustic waves below 6 GHz.*

Optical nanofibers (ONFs) have demonstrated their strong potential as photonic platforms for stimulated Brillouin scattering (SBS) due to their submicron size, which enables strong photon-phonon interaction and the generation of multiple acoustic resonances including both surface and longitudinal waves [1,2]. However, these multiple resonances have made it difficult to measure Brillouin efficiency using a conventional pump-probe method [3], and thus, to date, the stimulated backward gain has not yet been measured. In this work, we use a new heterodyne method for measuring Brillouin gain in the RF domain, which does not involve any optical filtering and allows us the gain of very close resonances to be measured. Our method was applied to a 13-cm long silica ONF with a diameter of 750 nm. Figure 1(a) shows the spontaneous Brillouin spectrum, which features three main acoustic resonances (TR21,L01,L02) in the ONF and one at 10.8 GHz due to standard single-mode fiber (SMF).

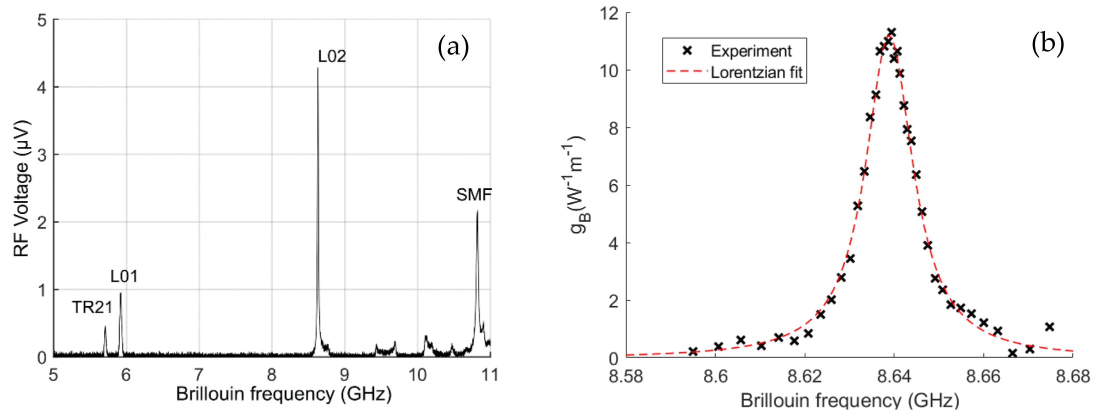

Figure 1: (**a**) Spontaneous Brillouin spectrum of a 13 cm long silica fiber taper with a 750-nm diameter. (**b**) Brillouin gain spectrum measured in the RF domain. The probe is scanned near the L02 Stokes resonance.

The gain curve shown in Fig.1(b) has been measured for the L02 Stokes resonance near 8.6 GHz. The gain coefficient g_B in $W^{-1}m^{-1}$ was measured from the amplification of a low power optical probe generated by an electro-optic modulator, assuming the signal amplitude on an electrical spectrum analyzer when the pump is turned on or off. The Brillouin gain was then calculated from the following equation: $g_B = \ln(V_{S_{ON}})/V_{S_{OFF}} / (P_P L_{eff})$, where $V_{S_{ON}}$ and $V_{S_{OFF}}$ are the probe voltages when the pump is on or off, P_P is the optical pump power (W), and L_{eff} is the effective length (m) [3]. A peak Brillouin gain of 11.3 $W^{-1}m^{-1}$with the L02 mode was achieved, as shown in Fig 1(b), which is 50 times larger than an SMF (0.24 $W^{-1}m^{-1}$). TR21 and L01 Stokes signal backscattered from surface acoustic waves (SAWs) have a peak gain of 3.5 $W^{-1}m^{-1}$ and 5 $W^{-1}m^{-1}$, respectively.

References

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