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Temperature and strain dependence of Brillouin frequency shift in polymer-coated chalcogenide optical microwires

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Chalcogenide-glass fibers offer a unique set of optical properties presenting an excellent platform for development of highly nonlinear optical devices for all-optical signal processing and mid-infrared applications. In optical fiber Brillouin scattering is a nonlinear process where two photons generate a co-propagating acoustic phonon through electrostriction. Enhanced stimulated Brillouin scattering (SBS) has also been evidenced in chalcogenide tapered optical fibers and in photonic chips [1, 2]. SBS is of particular interest because it has important implications in various fields ranging from optical fiber sensors to lasers. In this work, we report the dependence of Brillouin frequency shift on temperature and strain in polymer-coated chalcogenide (PMMA-As_2Se_3) tapered optical fibers with sub-micrometer waists (microwires). Our study shows that the temperature coefficient is linearly proportional to the increase of temperature (-3.05MHz/°C). When the temperature increases, the Brillouin shift decrease (Fig. 1a) contrary to standard silica fiber (+1.1MHz/°C) [3]. Moreover the theoretical temperature coefficient of chalcogenide glasses is equal to -1.17MHz/°C. The difference in thermal expansion coefficient in chalcogenide core and polymer cladding induces a strong thermal strain in PMMA-As_2Se_3 microwires. To verify this assertion, we measured the Brillouin gain spectrum dependence on strain (Fig. 1b). The Brillouin frequency shift change due to thermal strain is equal to -1.86MHz/°C and confirm the measurement of temperature coefficient in PMMA-As_2Se_3 microwires. We also demonstrate the possibility to design the microwire for sensing application by changing the dimension ratio between optical core and surrounding cladding. Thanks to their robustness and desired mechanical properties, hybrid PMMA-As_2Se_3 microwires are promising candidates for the development of ultra sensitive microwire sensor and athermal sensor.

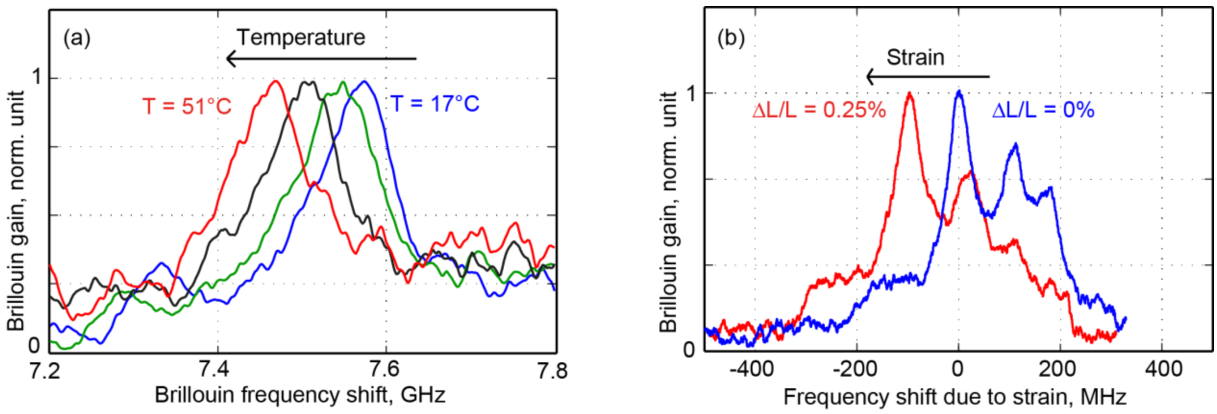

Fig. 1: (a,b) Brillouin gain spectra of a PMMA-As2Se3 microwire for different microwire temperatures and elongations, respectively.

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