Brillouin scattering in Bragg-based micropillar resonators at 300 GHz

M. Esmann[1], *A. Harouri*[1], *F.R. Lamberti*[1], *O. Krebs*[1], *P. Senellart*[1], *L. Lanco*[1], *I. Sagnes*[1], *C. Gomez Carbonell*[1], *A. Lemaître*[1], *and N.D. Lanzillotti-Kimura*[1]

[1]*Centre de Nanosciences et de Nanotechnologies, Centre National de la Recherche Scientifique, Université Paris-Sud, Université Paris-Saclay, C2N Marcoussis, 91460 Marcoussis, France*

Stimulated Brillouin scattering (SBS), one of the strongest nonlinearities in optics, has been successfully used in a wide range of applications in modern photonics. Due to its impact in telecommunications, SBS has been the subject of intensive research, motivating the engineering of mechanical modes and their interaction with light in optical fibers [1]. The precise measurement of Brillouin scattering is at the base of these efforts, and the control of high frequency vibrations one of the major challenges. In spontaneous Brillouin scattering the acoustic waves result from thermal fluctuations, and the scattering intensity is quite weak compared to that of the stimulated process [2].

Planar optical, Fabry-Perot-like microcavities have been widely used to enhance spontaneous Raman and Brillouin signals. Here we report on the Brillouin-scattering in optical micropillar cavities presenting three-dimensional confinement [3-5]. The optical resonators embed an acoustic resonator based on distributed Bragg reflectors confining a mode around 300 GHz [6,7]. We observe a strong non-linear dependence of measured signal on the incident laser power, which we attribute to thermally induced electronic and optical effects intrinsic to three-dimensional optical resonators. We implemented a free space measuring technique to extract the Brillouin scattering signal from a strong Rayleigh background. We propose an optimized spectral matching condition that takes into account the thermally induced dynamics to maximize the Brillouin signal. The reported micropillars are versatile in terms of acoustic and optical frequencies and have the potential to be integrated in more complex photonic systems.

References

[1] C. Wolff, M.J. Steel, B.J. Eggleton, and C.G. Poulton, Phys. Rev. **A** 92, 013836 (2015).
[2] A. Fainstein and B. Jusserand, in Light Scatt. Solid IX (Springer, Berlin, Heidelberg, 2006), pp. 17–110.
[3] S. Anguiano et al., Phys. Rev. Lett. **118**, 263901 (2017).
[4] F. R. Lamberti et al., Opt. Express **25**, 24437-24447 (2017).
[5] M. Esmann et al., submitted (2018).
[6] M. Esmann et al., PRB **97**, 155422 (2018).
[7] F. R. Lamberti et al., Appl. Phys. Lett. **111**, 173107 (2017).