ermal tuning of Brillouin resonance in free standing silicon nanowire

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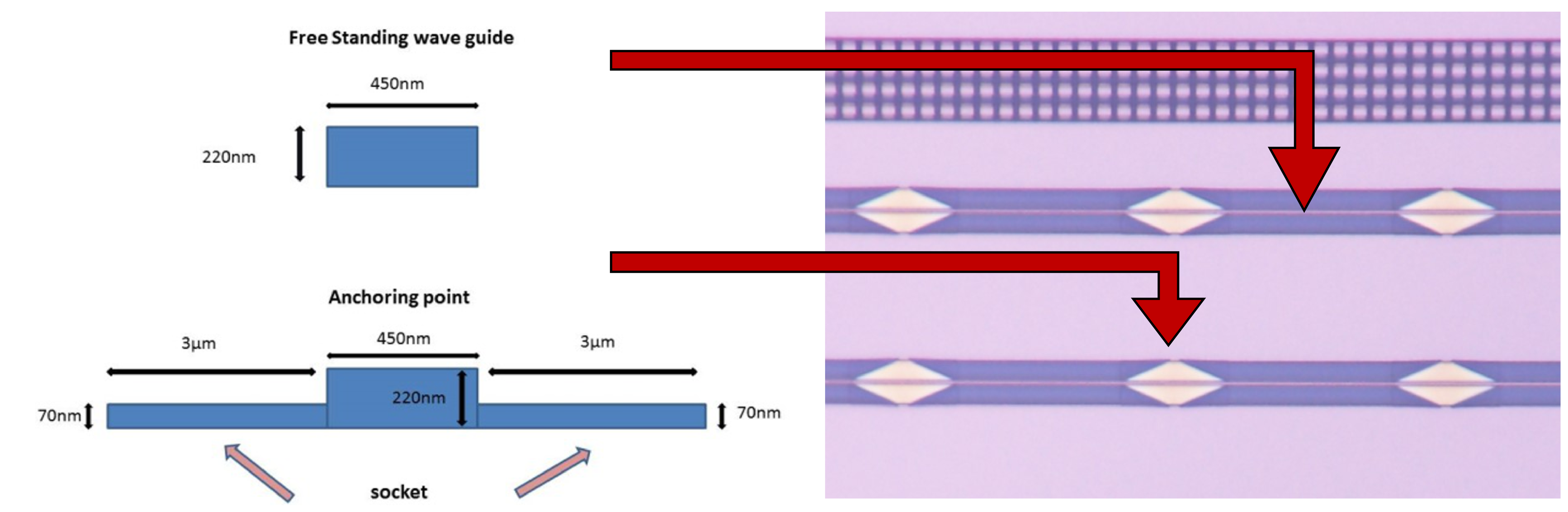
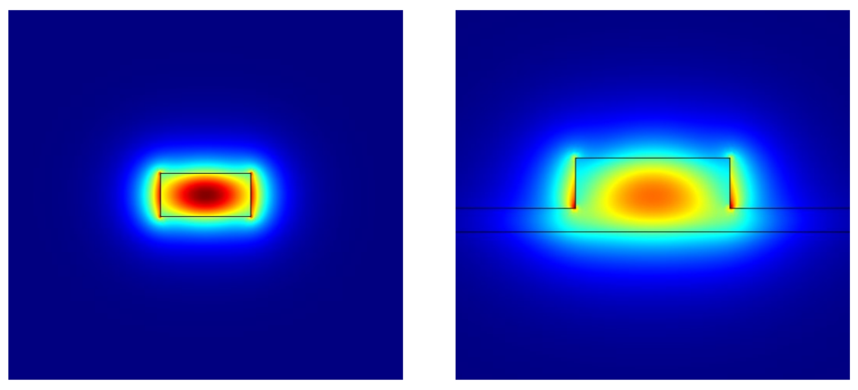
Introduction

- Stimulated Brillouin scattering (SBS) - a nonlinear process coupling an optical and a mechanical field [1].
- Brillouin resonance has been demonstrated in different silicon waveguide (WG) geometries [2][3].
- A small SBS gain can be used for realizing tunable and narrow band RF filters [4].
- The strong dependency of the mechanical resonance frequency, Ω, to the waveguide width allows tailoring of Ω but is also responsible for the decrease in mechanical quality factor, Q, due to inhomogeous broadening associated with fabrication imperfections.

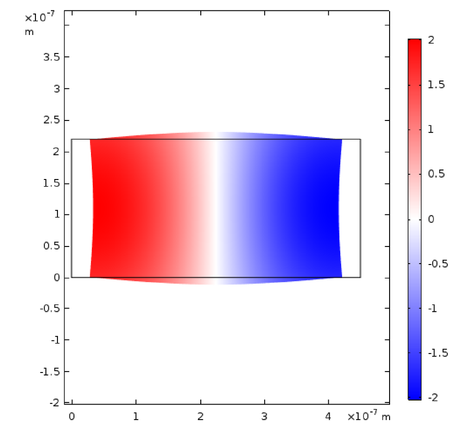
We demonstrate the possibility to thermally tune Ω and investigate the use of such tuning mechanism as a compensation mechanism for inhomogeneous broadening.



Free standing SOI waveguide side view and top view.

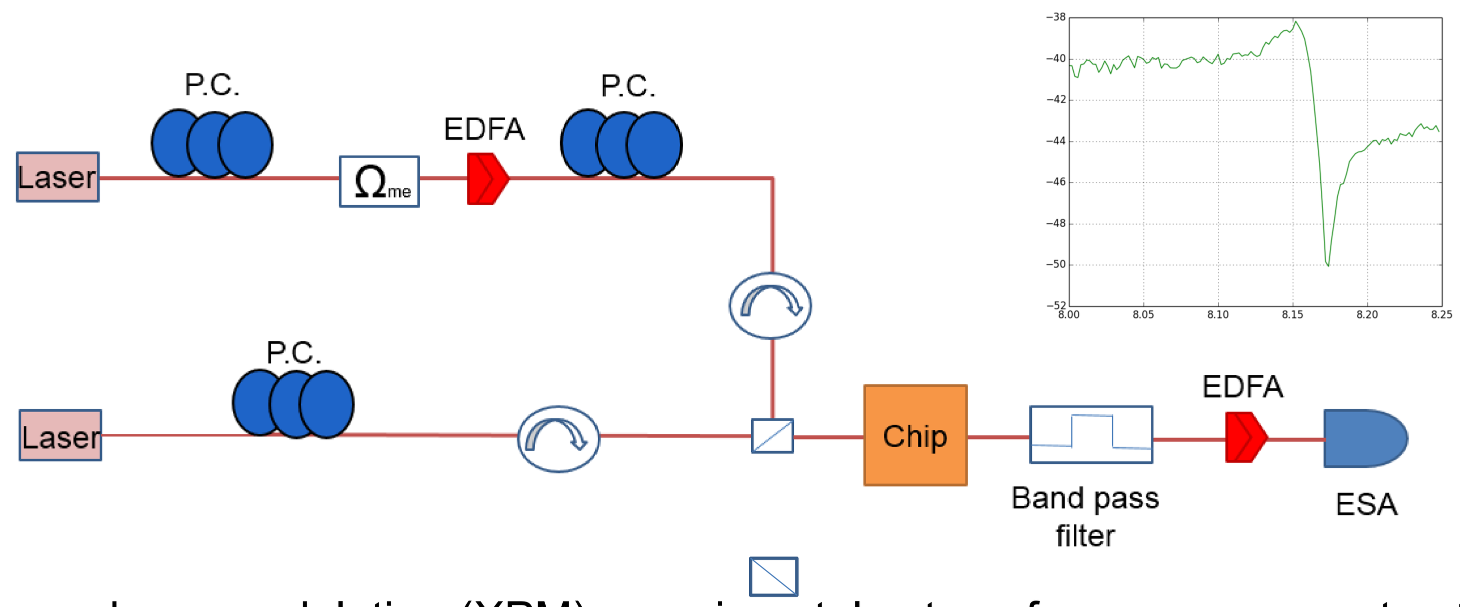


TE optical mode for free sanding waveguide and anchoring point.

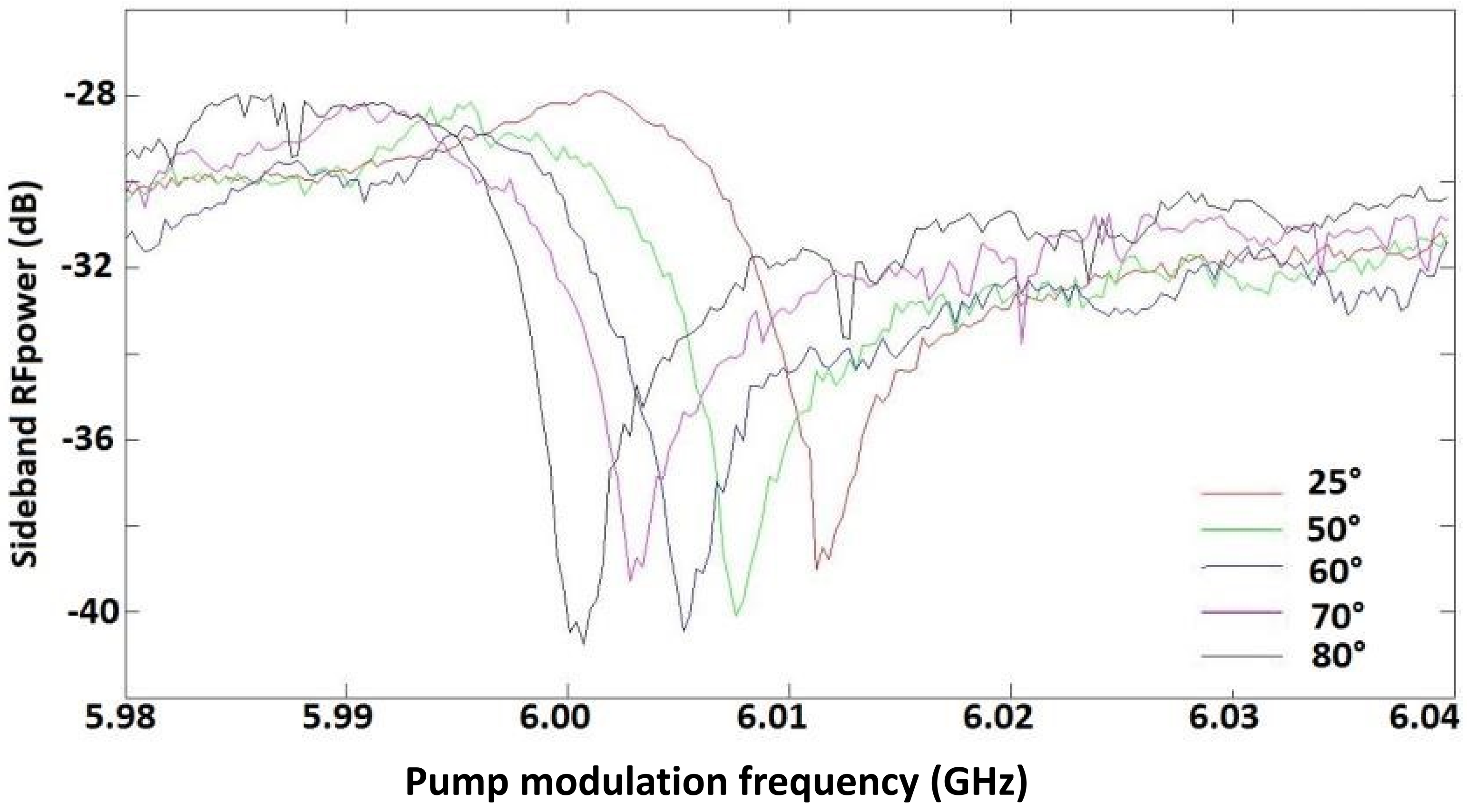


Mechanical mode.

Experimental Setup and Results



Cross-phase modulation (XPM) experimental set up, fano resonance at output.

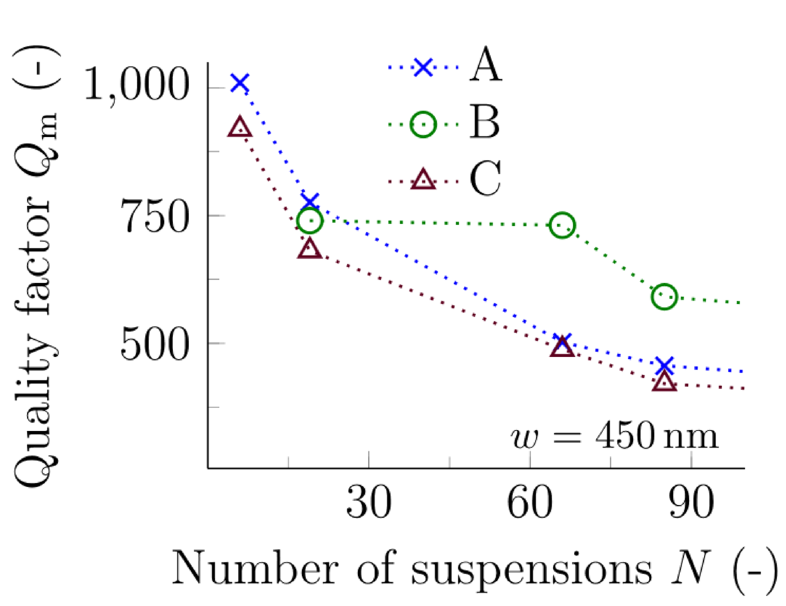


Fano resonance obtained using XPM experiment for 25°, 50°, 60°, 70° and 80 °

We can deduce the frequency shift ΔΩ for temperature variation of ΔT by:

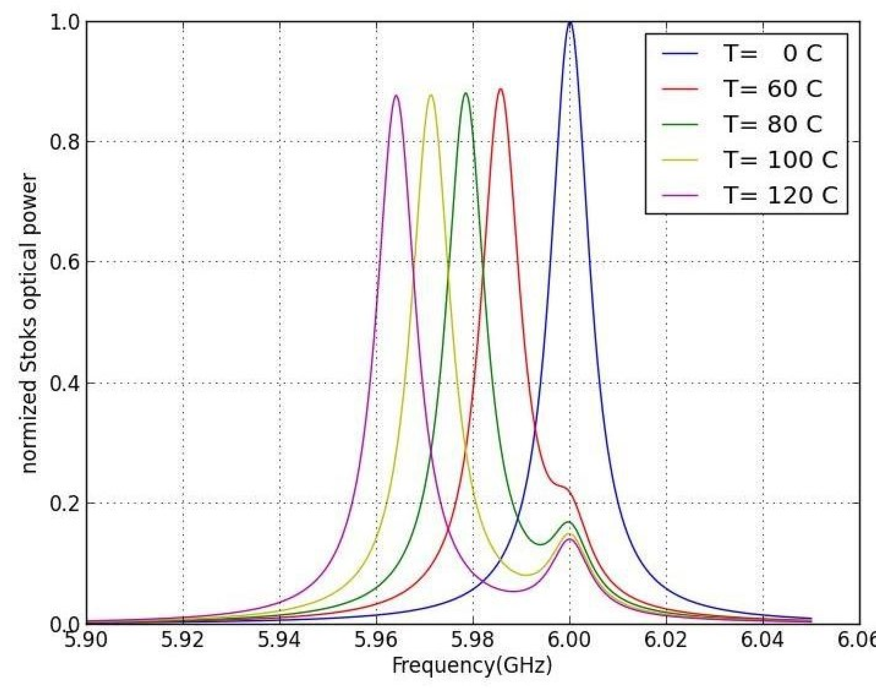
$$\Delta\Omega(\Delta T) = \Omega \cdot \Delta T \cdot S_{th}$$

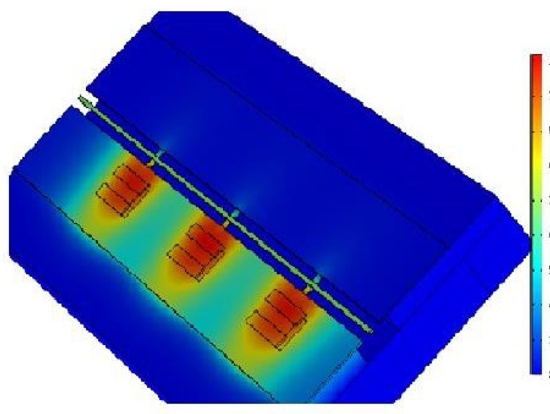
- *Ω=v/2w*, phononic Fabry-Perot model.
- ΔT=41.6 °C temperature difference needed for correct inhomogeneous broadening.

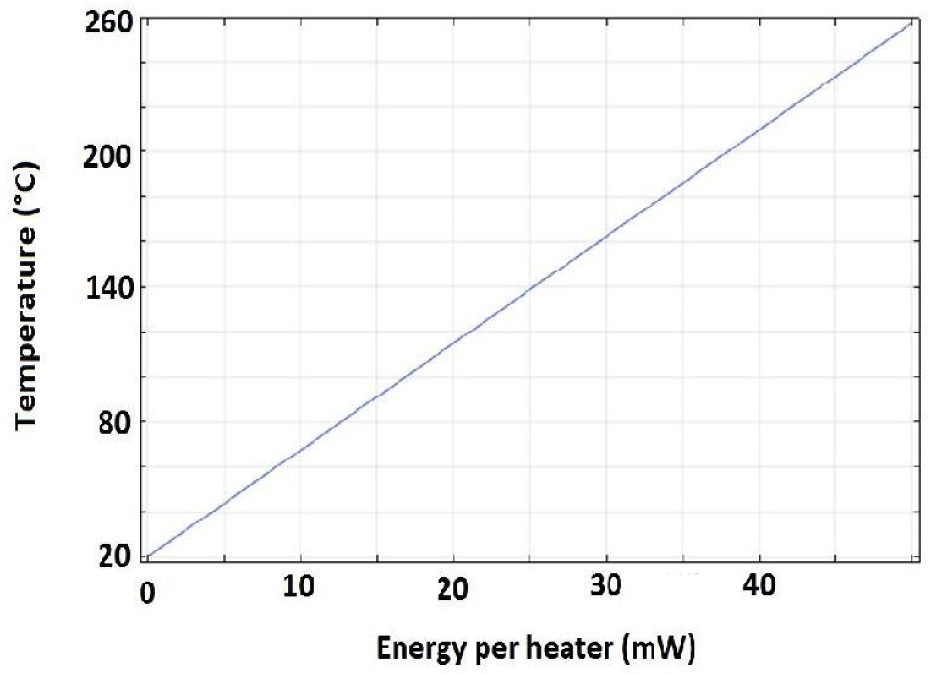


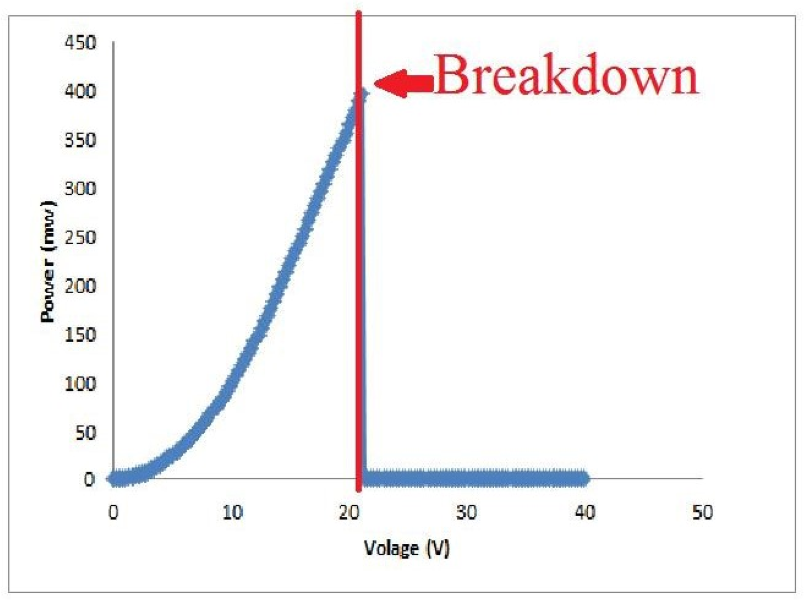
Further Work

- On-chip heaters allows individual tuning of various parts of the free standing waveguide.
- Resonance frequency, *Ωn*, of each individual subsection, *n*, can be individually measured.









References

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[2] Van Laer R. , Bazin A., & Kuyken, B. (n.d.). Net on-chip Brillouin gain based on suspended silicon nanowires. New Journal of Physics, 17(11).

[3] Van Laer, R., Kuyken, B., Van Thourhout, D., & Baets, R. (2015). Interaction between light and highly confined hypersound in a silicon photonic nanowire. Nature Photonics, 16

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