Net on-chip Brillouin continuous wave gain based on suspended silicon photonic nanowires

Alexandre Bazin*, **Raphaël Van Laer, Bart Kuyken, Roel Baets and Dries Van Thourhout**

[1]*Photonics Research Group, Ghent University--imec, Belgium*
& Center for Nano- and Biophotonics, Ghent University, Belgium
alexandre.bazin@intec.ugent.be

Development of Stimulated Brillouin Scattering devices onto the Silicon-On-Insulator platform are appealing to bring forward applications such as integrated RF filters, tunable delay lines or Brillouin laser. Recently, we observed Brillouin gain in silicon waveguides that were supported by a silicon dioxide pillar. Theses nanowires compressed both *194THz* photons and *9.2GHz* acoustic phonons to a silicon core of *450nm* width and *220nm* height, thereby realizing a large opto-acoustic overlap. However, they still suffered from clamping losses that limited the phonon quality factor to about 300 and the gain coefficient to 3100/(*W.m)*. Here, we report on silicon waveguides fully suspended for mechanical isolation purpose. The fabrication relies on creating, by means of UV lithography and HF-based wet etching, oxide anchors along each Si waveguide thus patterned with suspended nanobeams sections. The Brillouin gain profiles are obtained by injecting a strong pump signal with a weak probe signal, red-detuned, and whose frequency is scanned. Data analysis revealed quality factor and Brillouin gain coefficient up to respectively 1000 and 5500/(*W.m)*. The mild increase of the optical losses to 5.2*dB/cm* combined with high Brillouin gain resulted in a net gain of 0.5*dB*. This result is very encouraging as we were unable to saturate the gain with 40mW pump power when 25mW were enough in wires with oxide pillars. Carrier lifetimes measurements with decay times one order of magnitude smaller than previously measured could explain the low level of nonlinear losses, paving the way for new generations of silicon Brillouin amplifiers and lasers.