Anti-Resonant Reflecting Acoustic Rib Waveguides for Opto-acoustics

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Mutual strong confinement of light and sound in photonic waveguides is desirable for on-chip opto-acoustic nonlinear interactions such as stimulated Brillouin scattering (SBS), but very few materials are naturally guiding for both waves. A potential solution is to develop Anti-Resonant Reflecting Acoustic Waveguides (ARRAWs) [1, 2] which would confine sound waves to an acoustically-fast core using Fabry-Perot-like cavity anti-resonances of the cladding layer, with the light guided by conventional total internal reflection. In this work, we extend our initial studies of ARRAW guidance in idealised one-dimensional and cylindrical waveguides [2] to realistic rib geometries.

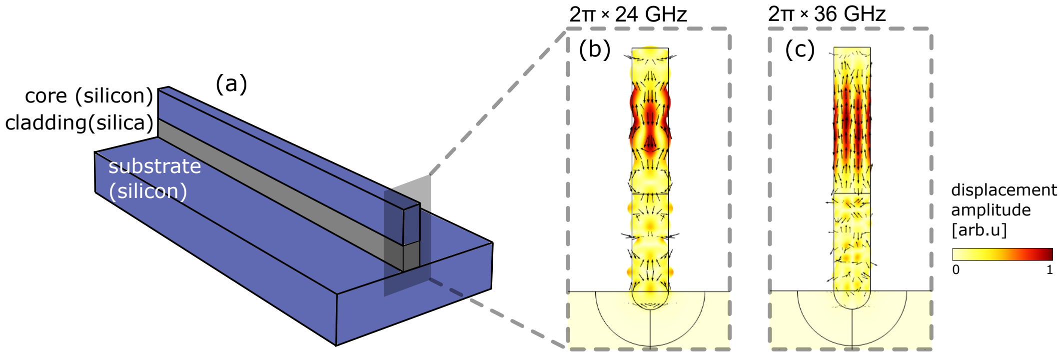

Figure 1: **(a)** The waveguide geometry of interest, with a Si core and SiO_2 cladding. **(b)** An example displacement profile of an anti-resonant mode. **(c)** An additional displacement profile of an anti-resonant mode. Note that this mode is orthogonal to that shown in (b).

Figure 1(a) shows a typical configuration for the silicon-on-insulator platform, silicon being acoustically fast compared to the cladding of silica. We looked for low-loss acoustic resonances of this structure in the GHz bandwidth suitable for SBS interactions using finite element simulation (COMSOL) with open boundaries. As shown in Fig. 1(b) and (c), by filtering for strong field localisation and low leakage loss, we identify a family of anti-resonant modes of a rib waveguide, with strong confinement to the acoustically fast core.

The anti-resonant acoustic guidance can be realised in a variety of rib waveguide designs, offering strong spatial confinement, and significant suppression of acoustic losses. It is thus particularly well suited for experimental realisation, and implemention as a platform for SBS in integrated optical circuits.

[1] M. A. Duguay et al., Appl. Phys. Lett. **49**, 13 (1986).

[2] M. K. Schmidt et al., New J. Phys **22**, 053011 (2020).