

mainly because the complicated mode profiles is spatially mismatched with the optical force distribution: the rapid spatial oscillation of the elastic modes cancels out the overlap integrals to a large extent.

5. Concluding remarks

In this article, we present a general framework of calculating the SBS gain via the overlap integral between optical forces and elastic eigen-modes. Our method improved upon the frequency response representation of SBS gains [31]. By decomposing the frequency response into elastic eigen-modes, we show that the SBS gain is the sum of many Lorentzian components which center at elastic eigen-frequencies. The SBS gain spectrum is completely determined by the quality factor and maximal gain of individual elastic modes. Therefore, our method is conceptually clearer and computationally more efficient than the frequency response method. Through the study of a silicon waveguide, we demonstrate that our method can be applied to both FSBS and BSBS, both intra-modal and inter-modal coupling, both nanoscale and microscale waveguides. Both analytical expressions and numerical examples show that SBS nonlinearity is tightly connected to the symmetry, polarization, and spatial distributions of optical and elastic modes. The overlap integral formula of SBS gains provides the guidelines of tailoring and optimizing SBS nonlinearity through material selection and structural design.

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