Silicon Photonic 2 X 2 Power Splitter with S-Bend Configuration

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INTRODUCTION

Power splitters are used for the purpose of redirecting, splitting, and combining light in silicon photonic circuits. They are used extensively in data communication applications such as wavelength-division-multiplexing and signal switching [1]. Their functionality is an integral building block for devices such as Mach-Zehnder interferometers (MZIs), polarization filters, and distributed Bragg reflector (DBR) based wavelength filters [2]. The power splitting ratio of a symmetric 2 x 2 power splitter shown in Figure 1. is based on the silicon-on-insulator (SOI) platform is explored by varying the coupling length (l_c) and the waveguide gap (g_c) using the Wave Optics Module in COMSOL Multiphysics®. This work also serves as a comparative study to validate COMSOL's ability to reproduce results from Lumerical Mode Solutions®, a popular integrated photonics modelling platform in simulating directional couplers with various power splitting ratios.

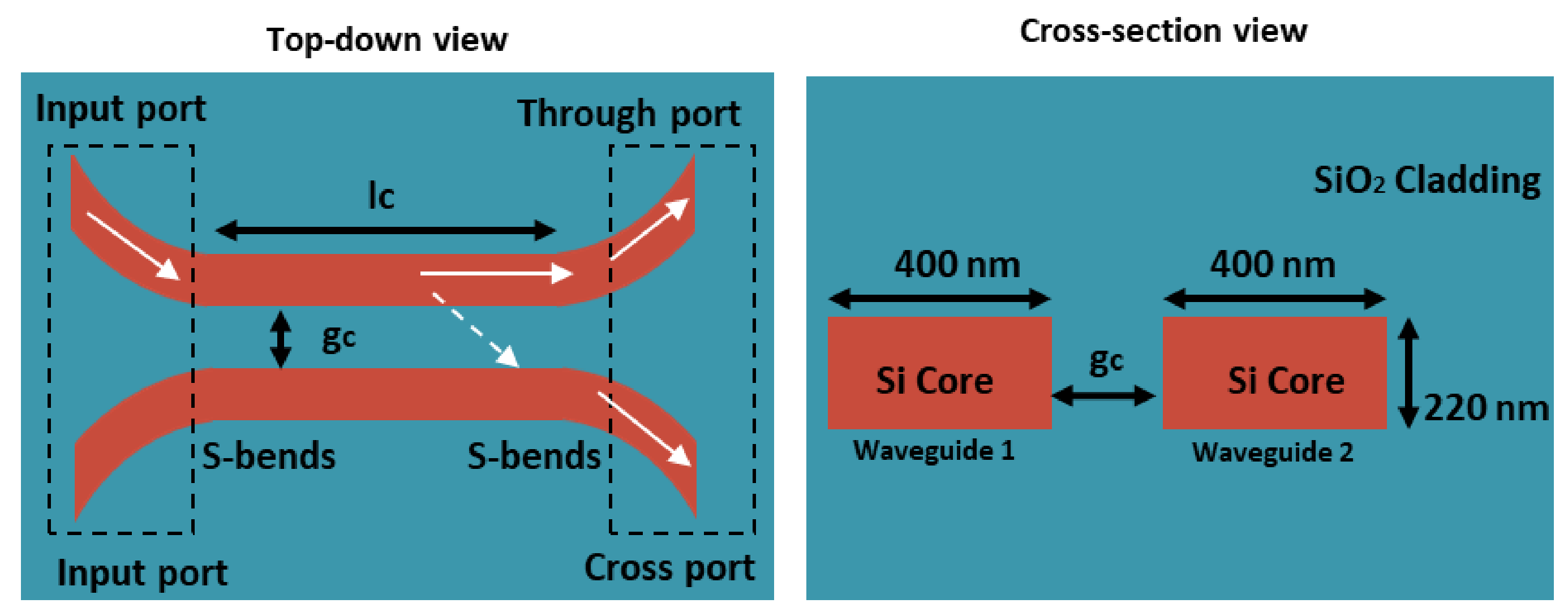

Figure 1. Schematic of a power splitter

COMPUTATIONAL METHODS

The 2D 4-port directional coupler, power splitter is simulated using COMSOL's Electromagnetic Waves, Beam Envelopes (ewbe) physics interface in the Wave Optics Module [5]. To study the wavelength dispersion of the power splitter, a parametric sweep over the wavelength range of $1.50\,um \leq \lambda \leq 1.60\,um$ is included. The refractive index (n) of Si and SiO2 are expressed as interpolated functions. This interface, which is based on the below equation is used when the model has a length that is much longer than the wavelength [5].

$$E(r) = E_1(r)e^{(-jk_1 \cdot r)}$$

RESULTS

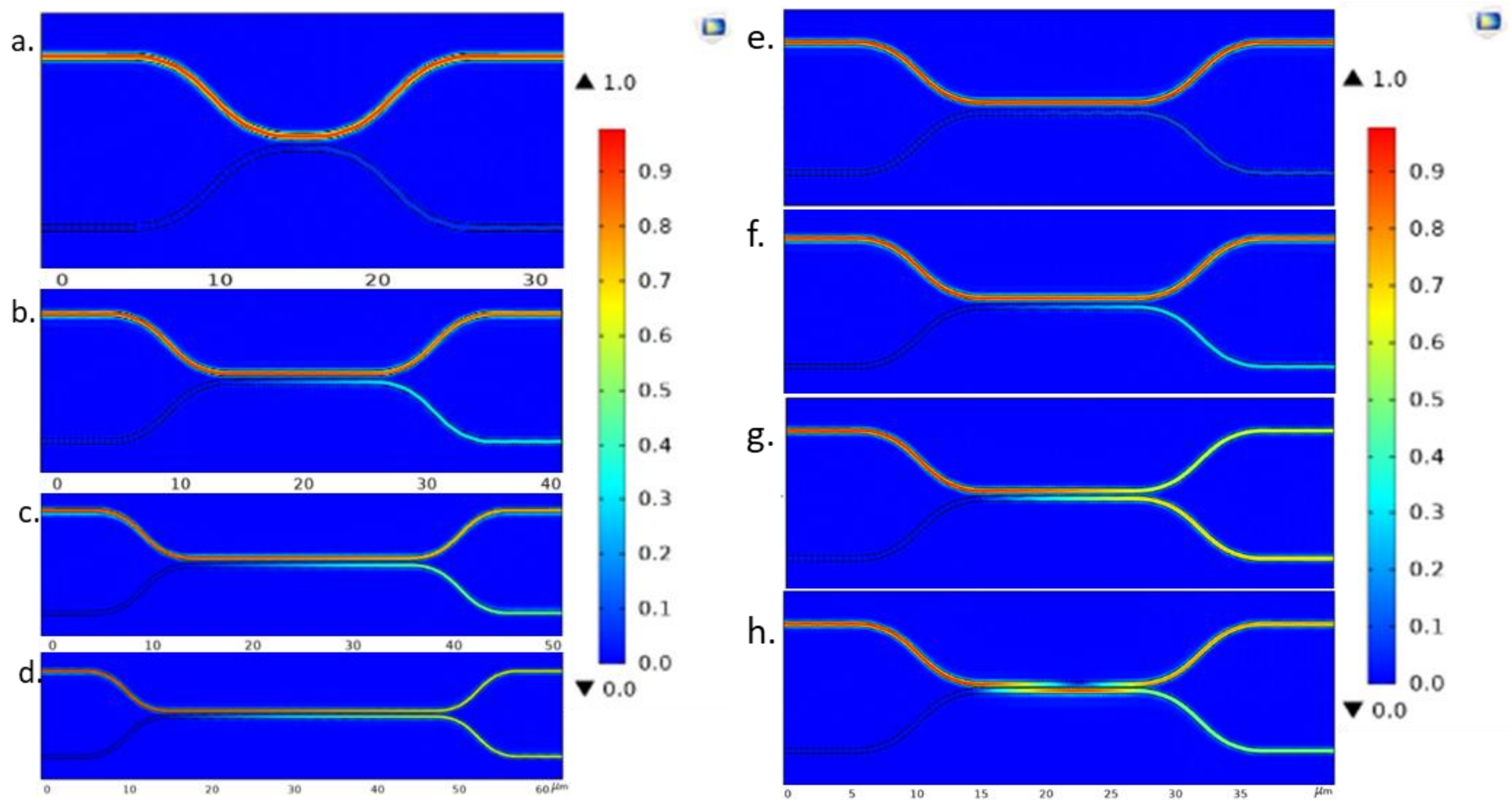

Figure 2. Normalized power distribution of power splitters for various coupling lengths: a. *lc*= 0 *um*, b. *lc* = 10 *um*, c. *lc* = 20 *um*, d. *lc*= 30 *um*. And waveguide gaps: a. *gc*= 0.4 um, b. *gc* = 0.3 um, c. *gc* = 0.2 um, d. *gc*= 0.1 um.

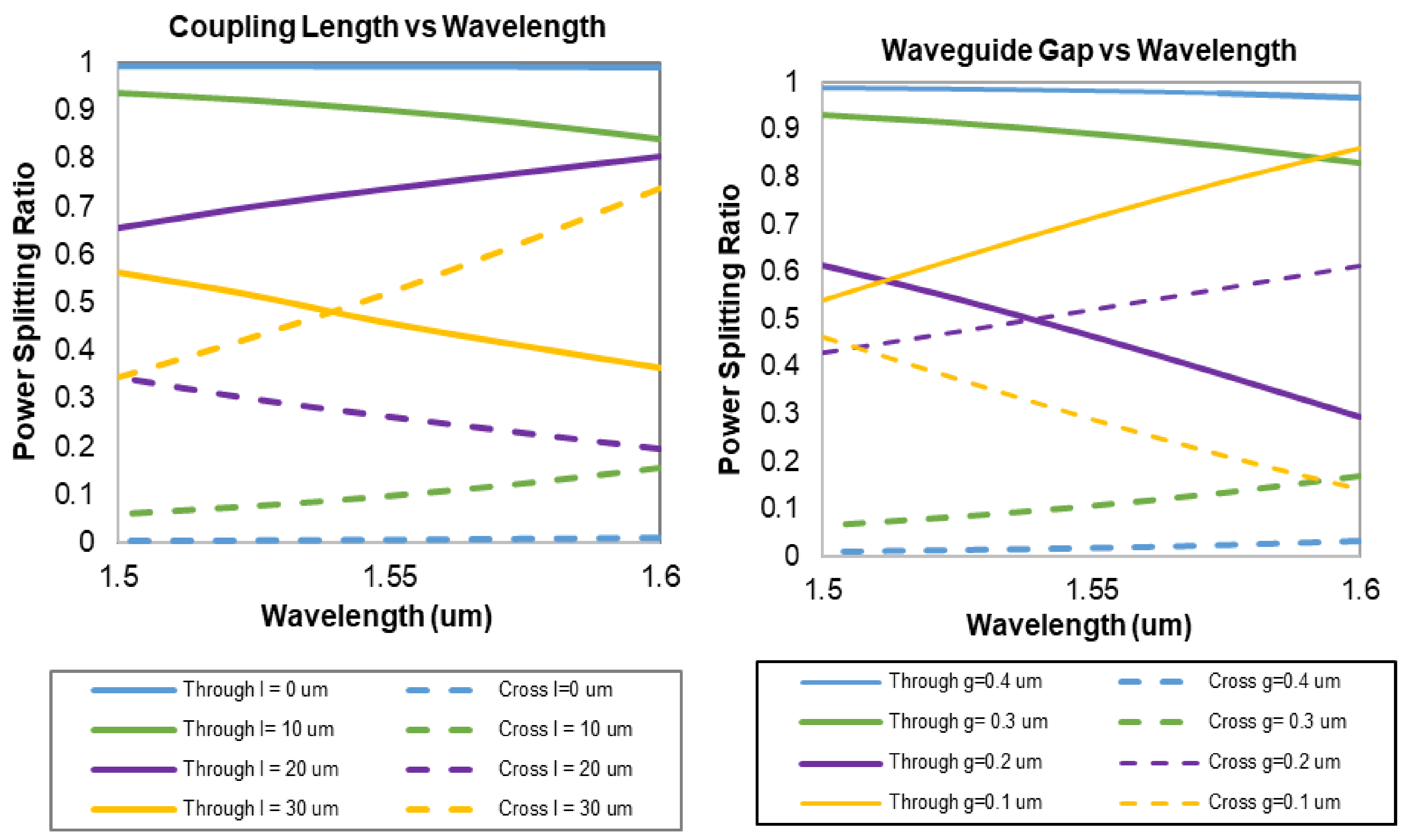

Figure 3. a. represents the power splitting ratio at the through and cross port as the coupling length (*lc*) is varied from 0 *um* to 30 *um*. b. represents the power splitting ratio as the wavelength gap (gc) is varied from 0.4 um to 0.1 um. The wavelength is swept from 1.5 *um* to 1.6 *um.*

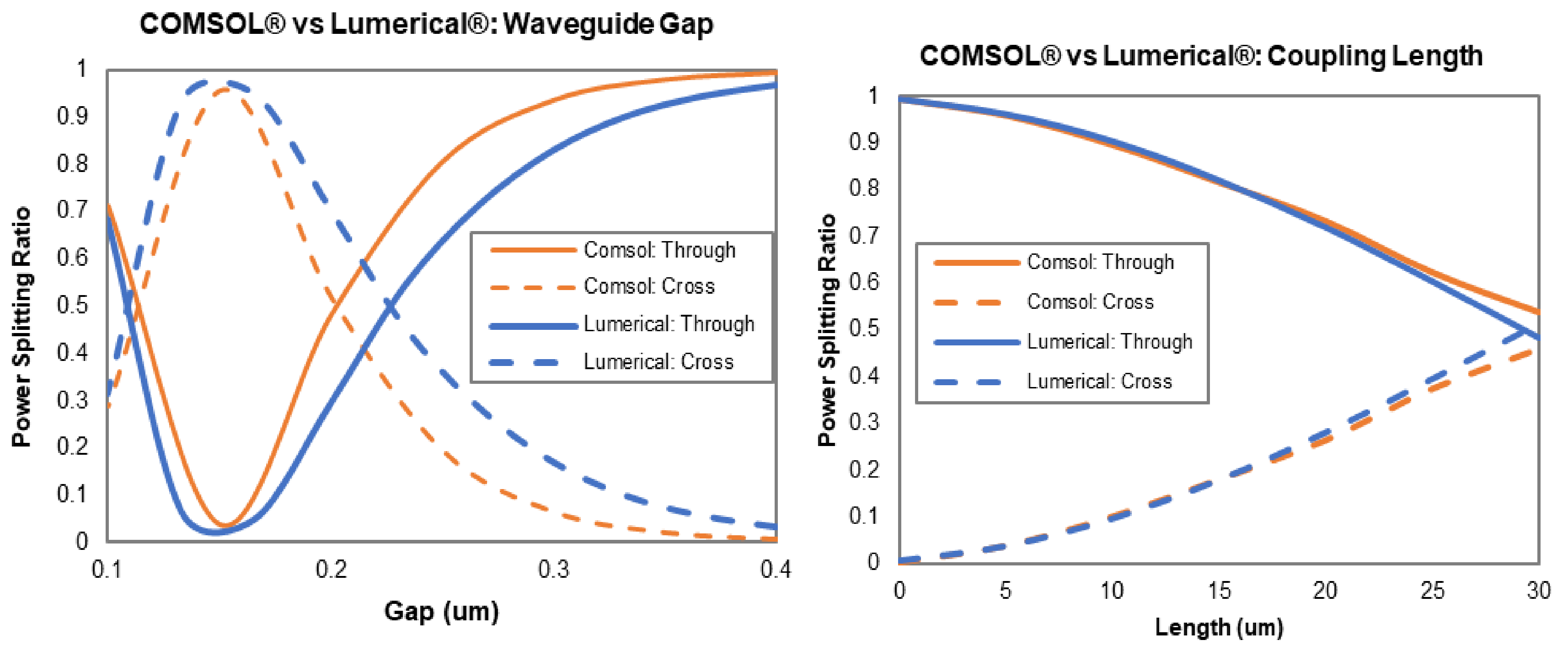

Figure 4. Both graphs depict the simulation results of Comsol and Lumerical. a. Shows the power splitting ratio as the coupling length (*lc*) is increased from 0 um to 30 um. b. Shows the power splitting ratio of the waveguide gap (*gc*) as it is increased from 0.1 um to 0.4 um. The solid and dashed blue line correspond to simulated COMSOL results. The solid and dashed orange line correspond to Lumerical results.

CONCLUSIONS

We have demonstrated COMSOL's ability in reproducing optical results. As the *lc* is increased from 0 *um* to 30 *um*, both software show that the power through and cross port become equally split. When *gc* is decreased, both software have the same coupling phenomena. While Lumerical is highly capable of solving simulation problems that are solely optics based, it does not allow users to include to real world physics contribution [6] in the way COMSOL can.

ACKNOWLEDGMENTS

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