Attractive and repulsive optical gradient forces between silicon waveguides

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I. Abstract

Besides optical cooling, optomechanics also provides an exciting and promising way to realize various optically tunable integrated components on a chip. Recently significant progress has been made to control gradient optical forces on a chip [1]. Here we present modeling, fabrication and characterization of a device which enables us to demonstrate attractive and repulsive optical gradient forces between two freestanding nanophotonic silicon waveguides on a Silicon-on-Insulator chip.

The sign of the force can be tuned by controlling the relative phase of the light that is injected into the waveguides. Phase control is possible by adding a Mach-Zehnder Interferometer in front of the suspended beams (Figure 1). Hence varying the wavelength allows us to excite each of the two propagating modes that exist inside the parallel waveguide structure. Intuitively in phase fields will favor the mode with the symmetric character while counter phase fields will excite the asymmetric mode preferentially. Optical gradient force that arises from the symmetric (asymmetric) mode is attractive (repulsive) [2]. The experiment was performed in a vacuum chamber in order to excite the beams resonantly ($Q_{MECH}\approx6000$). An excellent agreement between theory and experiment was found.

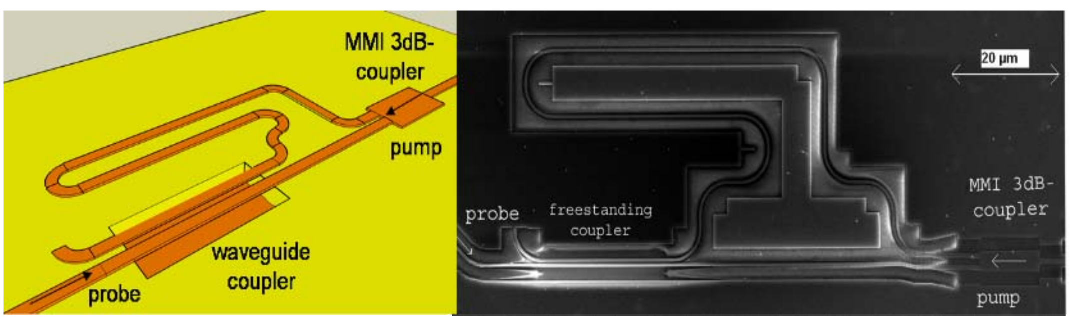

Figure 1: device concept (left) and SEM-picture (right)

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References

[1] M. Li et al, Harnessing optical forces in integrated photonic circuits, Nature 456, pp. 480-484 (2009)

[2] M. L. Povinelli et al., Evanescent-wave bonding between optical waveguides, Opt. Lett. 30, pp. 3042-3044 (2005)