Optical forces originate by radiation pressure and dipole induction on dielectric materials under strongly varying electromagnetic field profile. In this project we explore this phenomena to tackle a technical challenge in photonics: the optical interfacing between the optical fiber domain (mode diameter of tens of micrometers) and the integrated photonics domain (mode diameter of hundreds of nanometers). Typical approaches to launch light from one domain to another, either require submicron alignment precision (as in edge coupling with lensed fiber and inverse taper) or faces polarization and bandwidth limitations (as in grating couplers).

To overcome those limitations, our goal is to design a photonic coupler that is self-aligned by means of optical forces. On image 1 we show a schematic of our coupler concept. The geometry was chosen to allow high coupling efficiency, by matching effective indexes, and attractive optical force for center-to-center distances of over a micron.

The transmittance for a horizontally polarized input and a TE output shown on image 3. For taper positions at the axis, the guided modes have orthogonal polarization due to symmetry, meaning no beating and a constant transmittance with respect to \( z \).

Conclusions

Theoretical results show a self-aligned photonic coupler with optical force range of 1.25\( \mu \)m for optical-induced acceleration of 1g/mW and maximum coupling efficiency of -1.4 dB. Although the chosen geometry is not optimized, it shows better performance than grating couplers (-3.5 to -5 dB) and comparable to edge coupling (-1dB) with the advantage of coarser alignment precision. However, other mechanisms should play important role on the device actuation, such as Brownian motion and mechanical stresses, and will be explored.

Acknowledgement

This work is supported by FAPESP grant 2017/17855-0.
