On the Coupling between a Slab or a Channel Waveguide and a Laterally Polished Fibre

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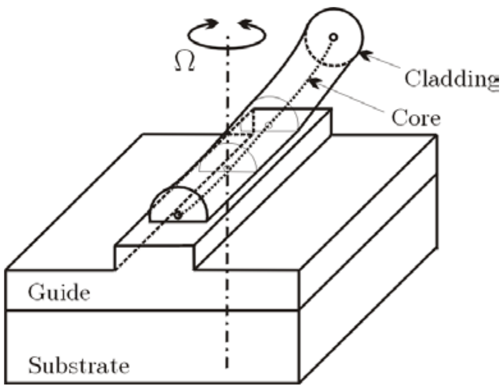
Although a number of various kinds of mode couplers have been extensively studied since the early years of integrated optics (see e.g. [1]), some quite essential contributions and remarks dealing with this topic have still appeared during last two decades [2, 3, 4].

The objective of our study is to analyze numerically by 3D-BPM and theoretically the 3D evanescent "fiber to channel" coupling structure as shown in the figure. We adopt the approach sufficiently exploited (fully transferred power from fiber to fiber) for example in [5], i.e. we assume the coupling through a single-mode fiber with a polished cladding (under a certain radius to reach the fiber core) to any waveguide. As also referred in [5] this polishing technique is quite well developed. This approach was further investigated both theoretically and experimentally in [6, 7]. As a prerequisite for our study, we follow the results from [4, 8], where the "fiber to fiber" coupling arrangement was extended to the coupling from the polished fiber to a slab. Actually, the paper [4] dealt with polarization properties of such a coupler.



We start with the simpler case of the "fiber to slab" interaction to embark into the theory. We assume generally a slab waveguide consisting of anisotropic materials (at least a substrate being anisotropic). The theory governing the process under study leads to the well-known pair of mutually coupled equations, which are omitted here for the sake of brevity. Contrary to the fiber-fiber coupler, the desired coupled power in the waveguide crucially depends on several factors, because of quite different nature of the coupling. Apparently, there is the fundamental need to keep the phase mismatch between the propagation constants in the fiber and the channel as small as possible (practically 10^{-4} cm^{-1}). Moreover, the coupler exhibits a "resonance like" behavior with respect to the wavelength [9]. As further shown in [4], the anisotropic device is also polarization sensitive (TE/TM). Our contribution extends the theory also for biaxial waveguides and generalizes thus the results reported in [4], i.e. some dependencies may be somehow relaxed and vice versa.

Some additional matching considerations over the spatial misalignment must be taken into account in the more complicated coupling between the fiber and the channel. Similar requirements to the classical phase-mismatch obviously hold for an angular misalignment Ω between the channel direction and the laterally polished part of the fiber (see figure).

References:

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