Coupling of photonic nanowires to k-mismatched waveguides and resonators

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We present results concerning the coupling of EM guided waves between dielectric photonic nanowires and k-mismatched waveguides and/or resonators.

We begin by describing the coupling between two identical cylindric nanofibers. A coupling model based on the evanescent fiel overlap is compared to a full three-dimensional finite-difference time-domain simulation obtained with the MEEP software package. The results are compared to those of other authors [1], and special emphasize is given to identify the limits of coupled mode theory based on perturbation theory in the present context. We find strong similarities with in fiber mode coupling in tapered optical fibers [2].
Subsequently, a k-mismatch is introduced into the coupling scheme, and the first order impact on coupling efficiency and beating length is investigated.

Care is taken to permit a direct comparison with an experimental setup, where the waist region of adiabatically tapered optical nanofibers represent the initial waveguide.

Next, we studied and analysed the coupling from a photonic nanowire to a single ring resonator, both in tapping and add/drop configuration. Through the conventional transmission spectra, we analyzed coupling efficiencies for the experimental parameter space, also in function of the k-mismatch. Also, we paid special attention to the evanescent field enhancement effect in the space between waveguide and resonator in the propagation direction. Fundamental and technical coupling limits are discussed.

Finally, we will discuss the important problem coupling efficient between cylindric photonic nanowires and high index materials and photonic crystals, and will present simulation results for these configurations.

References

[1] Keji Huang, Shuangyang Yang, and Limin Tong, "Modeling of evanescent coupling between two parallel optical nanowires", *Appl. Opt.* **46**, 1429-1434 (2007).
[2] M. Niehus, G.M.Fernandes, A.N.Pinto, "*Design of a tunable single photon interferometer based on modal engineered tapered optical fibers*, SPIE Proc. Photonics Europe 2010.

Figures

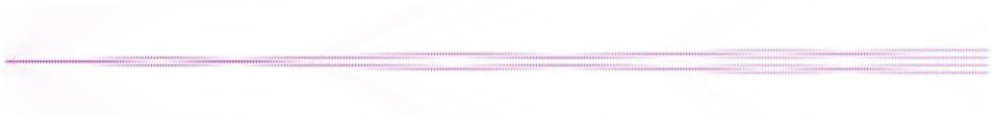

Figure 1 – One-to-four nanofiber beamsplitter simulated with FDTD

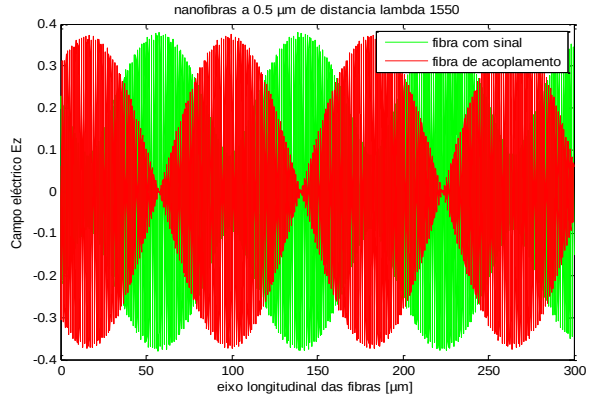

Figure 2- Periodic energy exchange between nanofibers due to evanescent field overlap-result of simulation

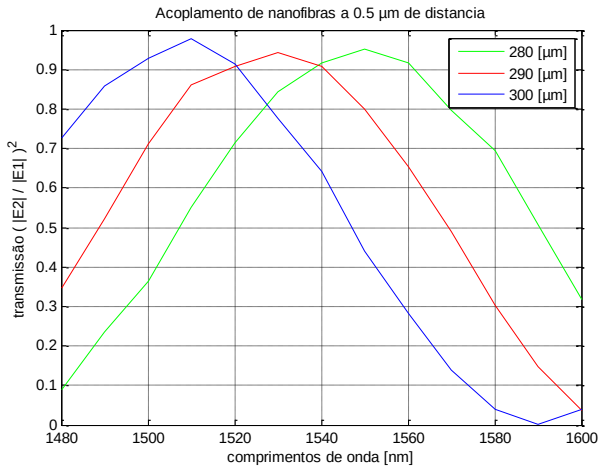

Figure 3 – Spectral transmission of coupled nanofibers

Figure 4 Periodic energy exchange between nanofibers due to evanescent field overlap- simulation