Electromagnetic Mode Simulation on Optical Fiber Coupling with Transversal Misalignment

P. F. Gomes[1], R. G. e Souza[1], F. Beltrán-Mejía[2], J. L. G. Arango[3]

[1]Universidade Federal de Goiás, Jataí, GO, Brazil
[2]Universidade Estadual de Campinas, Campinas, SP, Brazil
[3]Universidad de Pamplona, Pamplona, Colômbia

Abstract

Optical fiber guides are extensively used in telecommunications and studied in basic research. In these guides, the electromagnetic mode distribution is an important concept in the transmission through couplings between two fibers [1]. The transmission and power loss on this couplings are important commercial parameters and depend on the mode distribution. Many numerical methods have been used to calculate these transmitted intensities. In this work, we study this transmission coefficient through coupling between two fibers in two different cases.

We used COMSOL Multiphysics® software to calculate the mode distribution by numerically solving the wave equation in the fiber (Figure 1). The advantages of this method are: i) the possibility to choose an arbitrary geometry, ii) include any refraction index function into the equation, iii) set different parameters to each material and iv) a visual and simple interface when compared to traditional Fortran based algorithms.

We consider the transmission from the fiber 1 to the fiber 2. In the first case, the transmission was calculated as function of the wavelength of the propagated mode. We observed that the transmission for the fundamental mode on fiber 2 has a maximum at the same wavelength where the transmission for the first excited mode has a minimum (Figure 2). In the second case, the transmission was calculated as function of the transversal misalignment between the two fibers (Figure 3). The results show that the transmission of the fundamental mode has a maximum coupling when there is no displacement, which is expected. On the other hand, excited modes have its maximum with a nonzero misalignment, when the second fiber is dislocated from the first one (Figure 4).

These results are in good agreement with experimental ones. Other quantities can also be calculated, like the orbital angular momentum density of the optical field. It can also be used with other differential equation based theoretical models.

Reference

[1] - A. Ghatak and K. Thyagarajan, Introduction to Fiber Optics, Cambridge University Press, (1997).

Figures used in the abstract

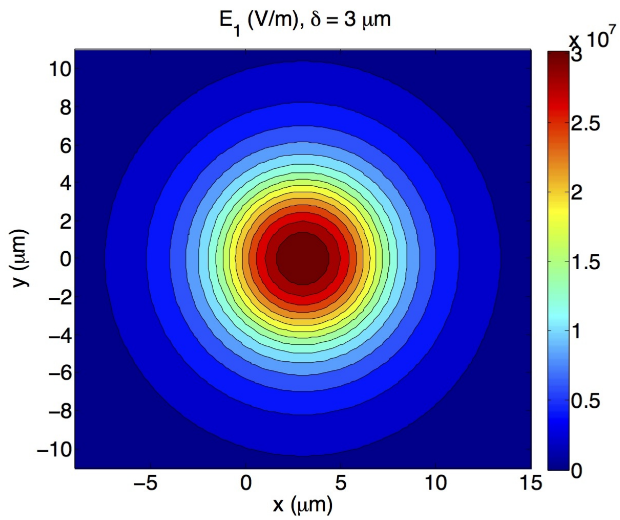

Figure 1: Spatial distribution of the electric field for the mode on the incident fiber.

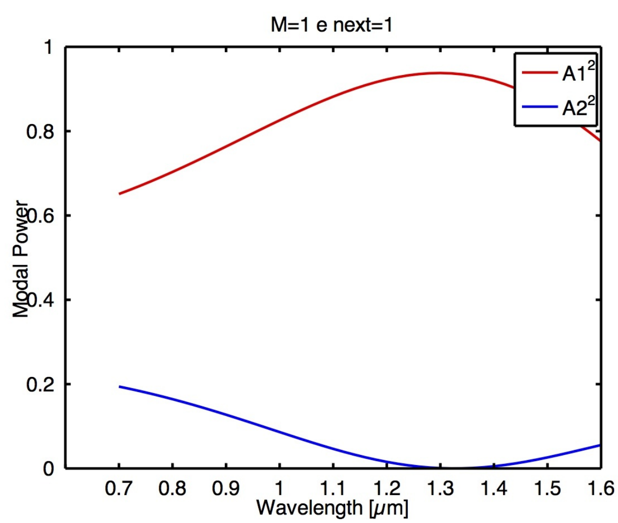

Figure 2: Power transmitted from the fiber 1 to the fiber 2, as function of the wavelength. A1 is for the fundamental mode on fiber 2 and A2 for the excited one.

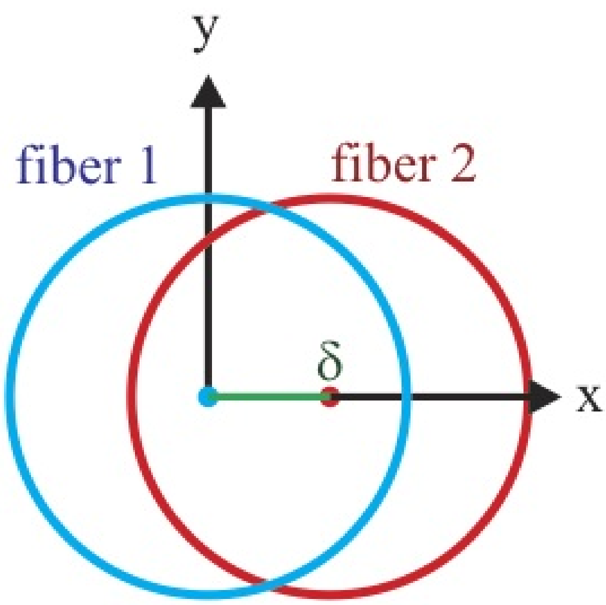

Figure 3: Illustration of the transversal view (xy plane) of the two fibers, where the fiber 2 is displaced by an amount delta from the fiber 1.

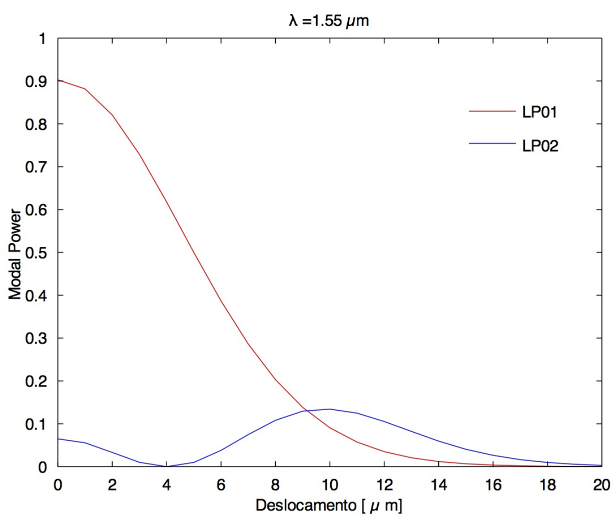

Figure 4: Power transmitted from the fiber 1 to the fiber 2 as function of the displacement delta. LP01 is for the fundamental mode on fiber 2, and LP02 for the excited one.