INTEGRATED OPTICAL CIRCUITS WITH SURFACE PLASMON POLARITONS

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Abstract. *This thesis presents innovative contributions to the study of metal-dielectric-metal (MDM) integrated optical circuits with surface plasmon polaritons, using the transmission lines analogy for microwaves, the transfer matrix theory and the even-odd method. In the last chapter, I studied a plasmonic pulse to see how its shape changes when passing through waveguides with a variable number of periodic cells.*

Keywords: Plasmonics, metal-dielectric-metal, logic gate, slot waveguide

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1. Introduction

Surface plasmon polaritons (SPPs) are non-radiative electromagnetic waves, confined to the interface of a metal with a dielectric, obtained following the interaction of light with the collective oscillations of free electrons in the metal. Their applications are in many important fields such as data storage, Raman spectroscopy, materials with negative refractive index at frequencies in the visible region, microscopy, solar cell fabrication, waveguides and the detection of biomolecules using sensors [1].

Integrated optical circuits could use SPPs for all the circuit's elements, which results in a miniaturization of circuits under the diffraction limit. SPPs can be used, for example, to fabricate very compact nanophotonic circuits and for optical interconnection on a motherboard. The study of integrated optical circuits with SPPs has many applications, which offer the possibility of theoretical investigation and practical realization of optical devices that can operate at the nanometric level [2].

2. Surface Plasmon Polaritons

Monochromatic transverse magnetic plasmonic waves (with frequency ω) are obtained at a metal-dielectric interface, as shown in Figure 1. This figure also illustrates the spatial distribution of the electric and magnetic fields of the SPP.

In agreement with the condition of continuity at the interface for the tangential components of the electric field, we find the dispersion relation of SPPs:

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