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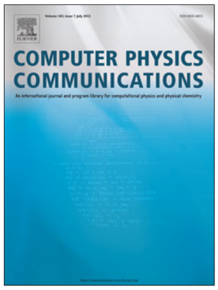

PII: S0010-4655(18)30207-8
DOI: https://doi.org/10.1016/j.cpc.2018.06.001
Reference: COMPHY 6531

To appear in: *Computer Physics Communications*

Received date : 10 July 2017
Revised date : 6 May 2018
Accepted date : 1 June 2018

Generalized Mode Solver for Plasmonic Transmission Lines Embedded in Layered Media based on the Method of Moments

Mai O. Sallam[a,b,c,*], Guy A. E. Vandenbosch[b], Georges Gielen[b], and Ezzeldin A. Soliman[a,*]

[a] *Physics Department, The American University in Cairo, P.O. Box 74, New Cairo 11835, Egypt*

[b] *ESAT-TELEMIC, Katholieke Universteit Leuven, B-3001-Leuven, Belgium*

[c] *Electrical Engineering Department, Ahram Canadian University, Giza, Egypt*

**mai.sallam@aucegypt.edu, * esoliman@aucegypt.edu*

This paper presents an integral equation formulation for the calculation of the propagation characteristics of plasmonic transmission lines embedded within a multi-layered structure. The Method of Moments (MoM) technique is adopted in this paper due to its superior advantages over other techniques including the finite difference and finite element methods. Plasmonic transmission lines consist of a number metallic strips of arbitrary shapes immersed within a stack of planar dielectric or metallic layers. These transmission lines can support one or more mode, each of which has its characteristic mode profile and it propagates with a certain propagation and attenuation constants. The developed solver is tested for different plasmonic transmission line topologies surrounded by various layered media. The obtained results have are compared to CST commercial software for verification. Very good agreement between the proposed solver and CST has been observed. The developed MoM solver requires much smaller number of unknowns if compared with those based on Finite Difference Time Domain (FD-TD) or Finite Element Method (FEM) such as Lumerical and CST.

1. INTRODUCTION

Over the last few decades, the field of plasmonics received considerable attention due to the unique properties of plasmonic materials at optical and visible wavelengths making them attractive for several applications [1]. The term “plasmonics” refers to the properties of metals at very high frequencies where light interacts with their free electrons resulting in the excitation of a surface wave, called Surface Plasmon Polariton (SPP). This wave propagates with high confinement along the interface between metallic/dielectric layers and exponentially decays away from it [2]. Such strong field confinement enables the design of optical devices of sub-wavelength dimensions [3]. Thanks to the advances in the fabrication technology, the manufacture of such extremely small devices is now feasible. The high field localization for plasmonic devices opened the gate for lots of applications based on light-matter interaction [4] including sensing [5, 6] and spectroscopy [7,8]. For sensing application, the spectral behavior of the transmitted or received power features either peaks or dips which are strongly affected by any variations in the medium surrounding the plasmonic sensor [9, 10]. Plasmonic devices could also be used for other applications including energy harvesting [11, 12] and optical telecommunications [13 – 15]. For energy harvesting applications, nano-antennas convert the electromagnetic waves in the visible/infra-red range into alternating voltage across the gap of the antenna. A rectifier is placed across this gap to convert the alternating voltage into