Computational Techniques for the Analysis and Design of Dielectric-Loaded Plasmonic Circuitry

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Guided-wave plasmonic components based on the dielectric-loaded plasmonic (DLSPP) waveguide are theoretically investigated by utilizing the finite element (FEM) and the beam propagation method (BPM).

Introduction

Plasmonic components are a prime candidate for nanophotonic circuits, combining the bandwidth of photonics along with nanoscale dimensions. The recently proposed DLSPP waveguide [1] is technologically simple and exhibits strong guiding properties. It is therefore suitable for densely integrated plasmonic circuits. Among the DLSPP-based components that have been demonstrated [2], microring resonator filters [2-3] and Mach-Zehnder interferometers are of substantial interest since they can provide the basis for the realization of switchable plasmonic circuits.

Results

Microring and microdisk resonator filters are investigated (Fig. 1) by utilizing the vectorial 3D finite element method. This choice is very natural given the resonant nature of these components, where the response is shaped by multiple interference effects between the circulating modes. For larger structures, such as Mach-Zehnder interferometers, a FEM solution becomes computationally expensive and in many instances prohibitive. In such cases, the presence of a clear direction of propagation along with the minimal level of reflections renders the BPM a favorable alternative. Though not as commonly utilized in plasmonics, our results indicate that it is a robust and valuable tool for the numerical analysis of such DLSPP-based components.

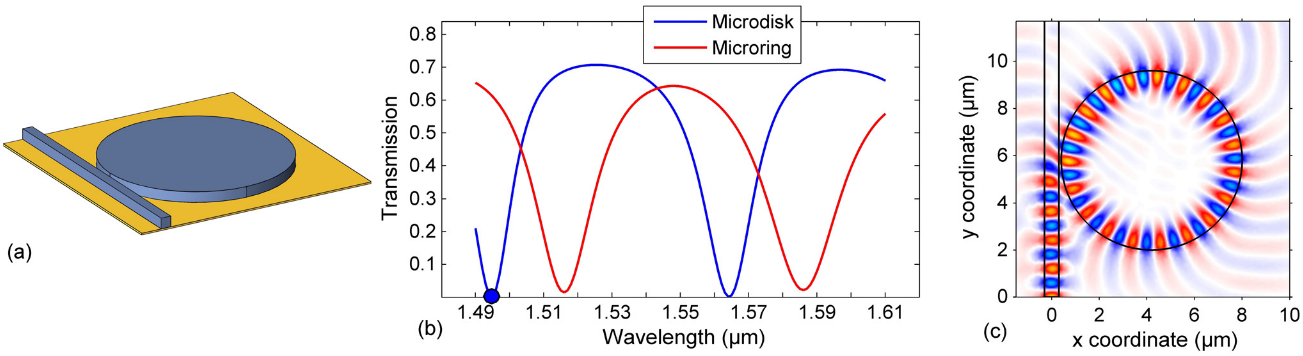

Figure 1: (a) Schematic of the simulated microdisk resonator filter, (b) Transmission versus wavelength for a microdisk (R = 3.5 μm) and a microring resonator filter of the same footprint (R = 3.8 μm), and (c) Real part of E_z at the transmission minimum marked in (b).

References

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