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# Photonic band gap and defect mode characterization in two dimensional plasmonic and dielectric photonic crystal

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ABSTRACT— **A numerical method, based on finite difference frequency domain (FDFD), for analyzing circular defect in two dimensional plasmonic photonic crystal with square lattice as well as dielectric one is presented. The band structure and defect modes are studied. The relation between band structure in unit cell and supercell is demonstrated. Furthermore the characteristics of modes are explained**

KEYWORDS: FDFD, Plasmonic PC, Dielectric PC, defect mode, band structure

## I. INTRODUCTION

Photonic crystals (PCs) have noticeable progress over the past two decades. Due to the existence of photonic band gaps (PBG) [1-2], by introducing a defect through PCs, localized modes can be created within a PBG. Thus, understanding the nature of these resonant modes is fundamental for various applications such as cavity resonators [3], coupled resonator optical waveguides [4], [5] and wavelength division multiplexing (WDM) [6]. A broad range of numerical methods have been presented to study the defect modes, including the plane wave expansion (PWE) method [7], the finite difference time domain [8]-[10], the transfer matrix method [11], and the finite difference frequency domain (FDFD) [12]. The defect modes have been widely investigated, in square and triangular lattices in two-dimensional PCs [7]-[9]. Defect can be imposed into 2D PC by removing rods, replacing it with other materials or just reshaping the inclusions [7], [13], [9].The effects of introducing a defect in dielectric PCs have been analyzed and almost a wide range of their applications has been discovered through many recent works. Previous studies show that when the filling factor of defect is larger than regular rod, doubly degenerate modes appear within PBGs which confirms our study [18].

In section **II** we explain FDFD method and derive eigenmode matrix equations for conventional photonic crystals and then for Drude model in dispersive plasmonic PC. Section **III** discusses the numerical results through band structure and defect modes in plasmonic and dielectric PCs. At last, conclusions are drawn based on all computation an result in section **IV.**