An Integral Equation Based Algorithm for Analysis of Surface Plasmon Polaritons

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Surface plasmons are charge density oscillations that occur at metal-dielectric interfaces. The periodic surface charge density creates a quasi-planar two dimensional electromagnetic waves that propagates along the interface, a surface plasmon polariton (SPP). Surface plasmon polaritons that occur at interfaces between two infinite media do not couple to external radiation. Periodicity in the metal layer facilitates coupling to the incident field. Interactions between SPPs and a periodic array of scatterers have been explored analytically (M. Kretschmann and A. A. Maradudin, *Phys. Rev. B*, **66**, 245408(8), 2002). The dispersion relation for SPPs was derived by Kretschmann *et al.* via a homogenous form of the reduced Rayleigh equation. Enhanced transmission properties of surface plasmons have been studied experimentally (H. F. Ghaemi, Tineke Thio, and D. E. Grupp, *Phys. Rev. B*, **58**, 6779-6782, 1998). Peaks in transmission are observed at wavelengths corresponding to surface plasmon polariton modes on both surfaces of a metal film with holes.

In this paper, we propose a frequency domain integral equation (FDIE) based technique for analyzing surface plasmon polaritons supported by a metal film perforated with a array of subwavelength cylindrical holes. The metal film is modelled via the Drude nearly-free-electron form of the dielectric function. The properties of the metal are accounted for explicitly by using the Stratton-Chu equations for the interior domain. The resulting equations are then reduced to a set of matrix equations by representing the equivalent electric and magnetic current in terms of RWG basis functions. Periodic green's functions are used to enable the analysis of infinitely long perforated structures. In the conference, we shall report our findings on (i) different metals and their response; (ii) the effect of period and perturbations to these; (iii) the effect of thickness of the film; and (iv) response as a function of frequency.