DESCRIPTION OF PLASMONIC SELF-IMAGING

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ABSTRACT

We study the surface plasmonic field and describe the condition under which the electromagnetic field presents the self-imaging phenomenon. The condition obtained in frequency space is analogous to Montgomery's condition for homogeneous media. The study is performed by describing the vector surface mode solution and we establish an analogous description with diffracted free beams. Arbitrary plasmonic fields can be described by a linear superposition of these surface modes obtaining an expression similar to the angular spectrum model from which we can analyze the charge distribution. We show that the surface self-imaging field allows one to generate capillary structures which offer applications like surface optical twisters to control and design nano-wires and nano-particles.

In general, the spatial fluctuations of the electric field associated with charges confined within small regions, can change abruptly indeed that the electric field can have very high values locally distributed. In principle, the control of these features on surfaces allows us to generate some important physical behavior, for example, induced transparency, control of fluorescence time, the possibility of generating surface tunable photonic crystals, synthesis of metamaterials, and surface optical twister, etc [1,2,3,4]. Such control implies the necessity to describe the optical field propagating along a surface by considering its geometrical parameters, being the main problem the control of the boundary condition. For a coherent plasmonic field, this boundary condition consists in a known stationary charge distribution. This point of view implies the description of surface elementary solutions known as surface mode solutions or plasmon modes. These solutions are analogous to homogeneous modes for free space known as diffracted free beams [5,6]. Arbitrary plasmonic fields are described by means of the superposition of elementary plasmon modes; the mathematical representation corresponds to the angular spectrum model for plasmonic fields. This representation allows us to obtain the stationary charge distribution associated to the electromagnetic field propagating on the surface. For greater clarity in understanding this charge distribution, we describe plasmonic standing waves by means of the coherent superposition of two mode plasmon waves propagating in opposite directions. The stationary character of the nodes implies a stationary charge distribution, where the spatial period between charges is in inverse relation to the modulus of the dispersion relation function. This property implies a separation between charges of the order of the wavelength used. Other details and applications concerning the behavior of charge distribution on surfaces can be founded in [7]. The charge distribution can be implemented as the boundary condition to generate other kind of surface optical fields. In particular we describe the spatial charge distribution whose spatial evolution generate plasmonic self-imaging fields. This analysis is performed in the frequency space and the condition obtained is analogous to the Montgomery´s condition for homogeneous media [8,9]. The point of view presented allows incorporating other kind of features, such as the Lau effect in order to obtain a reinforced of the self-imaging plasmonic field also as the incorporation of partially coherent effects [9]. The kind of surface optical fields generated offers application as surface optical twisters.

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