Abstract

Plasmons in Nano-wires and Left-handed Plasmonic Materials

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Received: Fri, 15 Mar 2002 11:31:09

Recently, the problem of EM field distribution for long and thin nanometer-sized needles (nano-wires) has attracted growing interest (see, e.g., [1]). We consider metal needles, whose diameter is much smaller than the wavelength of incident light, and whose length is of the order of the wavelength. The electromagnetic field distribution for nanowires is found, by using the discrete dipole approximation beyond the quasi-static approximation as well as analytical solution for a plasmon localized in a nanowire [2]. By using these approaches we simulate the field distribution for individual nm-sized metal needles and for a percolation composite formed by such needles. For individual needles, it is found that the surface plasmon polaritons can be excited, resulting in large local fields. For percolation composites formed by the needles, our simulations suggest localization of the plasmons and strong local field enhancement associated with these localized plasmons. The theory is in agreement with the near-field optical experiments performed by Moskovits' research team in UCSB [3].

We also show that in plasmonic composite nanomaterials both dielectric permittivity and magnetic permeability can be negative, opening up new means for fabricating left-handed materials [2], with the negative refractive index in the visible and near-infrared parts of the spectrum. Specifically, such optical left-handed materials can be fabricated, using metal nano-wires or metal-dielectric percolation composites [2,4].

References

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