EuroSciCon Joint Event on
Laser Optics,
Quantum & Plasma Physics

May 09-10, 2019
Stockholm, Sweden

J Electr Eng Electron Technol 2019, Volume:8
DOI: 10.4172/2325-9833-C1-015

REVIEW OF NANOCOMPOSITES AND ATOMISTIC METAMATERIALS

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Composites made of periodic subwavelength metal/dielectric structures that resonantly couple to the electric and/or magnetic components of the incident electromagnetic fields, exhibiting properties that are not found in nature are named as metamaterials (MMs). This class of micro- and nano-structured artificial media has attracted lots of attention during the past 15 years providing a fertile ground for ground-breaking electromagnetic and photonic phenomena. Practical applications of MMs have been delayed due to the high losses and strong dispersion associated with the resonant responses and the use of metallic structures, as well as the difficulty in fabricating the micro- and nanoscale 3D structures. The novel materials, for instance graphene or transparent-conducting oxides, employed to the nanocomposites can greatly suppress the undesirable losses. It is worthwhile noting, that three-layered nanocomposites enable an increase of the frequency range of the surface wave existence. This paper reviews recent progress in the physics of nanocomposites. An overview of key concepts such as effective medium approximation is provided, and nanocomposites based on the three-layered structure are introduced. Dispersion properties, absorption and propagation lengths of surface plasmon polaritons are analytically estimated. The variation of graphene dielectric functions is described by the Drude model. An overview of graphene nanocomposites reveals their ability to support the Ferrel-Berreman modes under the certain conditions. On top of all, the key factors influencing propagation length along with the absorption enhancement highly desirable in terahertz photoconductive antennas are analytically identified and analytical variations aiming to tune the dispersion relations are considered.

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