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Correlation between electron mobility and static dielectric permittivity of n-InSb

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Numerical calculations of the static dielectric permittivity- dependent electron mobility due to different types of elastic scattering mechanisms for n-type InSb were carried out. The calculated static dielectric permittivity increases by increasing of donor concentration. The temperature dependence of the electron mobility from 10 K up to 300 K has been demonstrated. Generally, the electron mobility shows peak behavior in this range of temperature. The direct correlation between the electron mobility and the static dielectric permittivity at 300 K was investigated. The dependence of the electron mobility on donor concentration was discussed when the static dielectric permittivity is assumed to be varying and when it is assumed to be a constant. The difference in behavior was noticed particularly at high donor concentrations.

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Study of quantum optics in metamaterial nanostructures

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We study the photoluminescence (PL) and spontaneous emission of semiconductor nanoparticles doped in a metamaterial heterostructure. Metamaterials are a new class of artificial materials with optical properties determined by their classical atomic composition and nanoscale organization of their structural components [1-4]. Metamaterials have unique electromagnetic properties which cannot be obtained from naturally occurring materials. Recently, metamaterials based on periodic arrangements of metallic nanocomposites have received special attention. They possess simultaneously negative effective dielectric permittivity and magnetic permeability for a range of frequencies in the electromagnetic spectrum. It is well known that the negative electric permittivity in noble metals leads to the formation of surface plasmon which may generate exceptionally strong localized electromagnetic fields. Heterostructures studies here are formed by fabricating a split-ring resonator and metallic rod metamaterial on a dielectric substrate. An ensemble of quantum dots (QDs) are doped near the interface in the heterostructure. The QDs interact with surface plasmon polaritons of the heterostructure. PL spectrum and spontaneous decay of excitons in the QD are studied. Our results indicate that the PL and spontaneous emission of the QDs are enhanced in the presence of the metamaterial when the exciton and surface plasmon frequencies are resonant. These findings are consistent with recent experimental studies. The present study can be used to make new types of nanoscale optical devices for sensing, switching and imaging applications based on metamaterials.

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