

# Nanotechnology Congress & Expo

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### Study of quantum optics in metamaterial nanostructures

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. 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) is 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.

### Biography

Professor Mahi R. Singh received both M.Sc. (1970) and PhD (1976) degrees from Banaras Hindu University, Varanasi in condensed matter physics. After that he was awarded an Alexander von Humboldt Fellow in Stuttgart University, Germany from 1979 to 1981. Between 1981 and 1985 he was a Research Associate and Lecture at McGill University, Montreal, Canada. From 1982 to 1983 he worked in INSA, Toulouse, France as a visiting scientist. He also worked as Research Associate at University of North Carolina, Chapel Hill, USA. After that he joined the University of Western Ontario as associate professor in 1985. Currently he is professor in this university. He was a visiting professor at University of Houston, USA from June till November in 1992. He also worked as a chief researcher at CRL HITACHI, Tokyo between November 1992 and May 1993. In summer 1993 and 1994, he was a visiting professor and Royal Society Professor at University of Oxford, UK. He was the director of the Centre of Chemical Physics at the University of Western Ontario, Canada. He also served as the director of Theoretical Physics Program for many years and as a senator at the University of Western Ontario. Dr. Singh has worked in many research areas of science and technology including nanoscience, nanotechnology, nanophotonics, plasmonics, optoelectronics, photonic crystals, Metamaterials, semiconductor heterostructures, high temperature superconductors, positron annihilation, Josephson Junctions, many body theories, condensed matter physics, semiconductor devices, Thermal Transport, DNA Molecules and DNA wires and so on. He has published more than 250 papers in International journals. He has written several books which are used as text books at UWO, Canada. He has organized several International conferences. He has been invited as a plenary and an invited speaker in several international conferences throughout the world.

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