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Polaritons in a non-ideal periodic array of microcavities containing ultracold quantum dots

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Fabrication of novel materials for the creation of sources of coherent radiation is presently a vast interdisciplinary area of theoretical and experimental investigations, which involve condensed matter physics, nanotechnologies, chemistry as well as information science. In this connection, some promising vistas can be opened by the so-called polaritonic crystals, which represent a particular type of photonic crystals featured by a strong coupling between quantum excitations (excitons) and electromagnetic waves. The important features of photonic band-gap structures under discussion are connected with 'slow' light, which is one of the promising fundamental physical phenomena that can be explored in the design of various quantum optical storage devices. In particular, the effective reduction of the group velocity demonstrated in the associated optical waveguide resonators. Based on the representations of the ideal photonic structures, the non-ideal systems of this class - polaritonic crystal, which is a set of spatially ordered microcavities containing ultracold atomic clusters, is considered. Moreover, the spatial distribution of cavities (microresonators) is translation invariant, and the atomic subsystem has randomly distributed defects: Impurity atomic clusters (quantum dots) or a vacancies. Numerical modeling of dependence of the dispersion of polaritons in this imperfect lattice of associated microresonators on impurity concentration is completed. Using the virtual crystal approximation, the analytical expressions for polaritonic frequencies, effective mass and group velocities, as a function of corresponding quantum dots and vacancies concentrations, is obtained. It turned out that even with a small number of vacancies in the lattice (one position for a thousand resonators) weight polaritons increases by three orders of magnitude. These results enable to extend the possibility of creating a new class of functional materials - polaritonic crystal systems.

Biography

Vladimir V Rumyantsev is Professor in Nanophysics Department at Donetsk National University (DonNU) and Head of Physics Technology Subdivision at Donetsk Institute for Physics and Engineering (DonPhTI). He received PhD in Physics (1988) from DonNU and Doctor of Science in Solid State Physics (2007) from DonPhTI. He has published more than 200 scientific publications. He is Group Leader of International project in the framework of the European program FP7-PEOPLE-2013-IRSES (2013-2016).

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