HIGH TEMPERATURE EXCITON RECOMBINATION IN SILICON AND SILICON NANOSTRUCTURES

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S u m m a r y

Conditions for the manifestation of radiative and nonradiative exciton recombination in bulk silicon, silicon barrier structures, and nanostructures at room temperature are discussed. The role of exciton recombination mechanisms in the electroluminescence and photoluminescence of silicon diode structures is considered. Two mechanisms of such a luminescence are described, one of which can be realized in dislocation-free silicon structures, whereas the other one in silicon structures with dislocations. The features of a theoretical approach to the consideration of low-dimensional semiconductor structures are described. The character of the exciton energy spectrum transformation at lowering the system dimensionality is clearly demonstrated. A model of the recombination in silicon nanostructures is developed, and the results of the theoretical modeling of photoluminescence spectra in a Si—SiO$_x$ quantum well, a quantum wire, and quantum dot structures are analyzed. The experimental and simulated photoluminescence spectra are compared. We show that the photoluminescence in silicon nanostructures has the excitonic nature even at room temperature. A special emphasis is made on the manifestation of the quantum mesoscopic effect in the broadening of photoluminescence spectra due to a relative growth of the influence of different atomic-scale fluctuations in the systems with a small amount of constituting particles on the energies of exciton transitions at least in one of the size quantization directions.