COLLECTIVE BEHAVIOR OF INTERWELL EXCITONS LATERALLY CONFINED IN GaAs/AlGaAs DOUBLE QUANTUM WELLS

V.B. Timofeev

Institute of Solid State Physics, RAS, Chernogolovka 142432, Russia

The luminescence of interwell excitons in GaAs/AlGaAs coupled quantum wells (n-i-n heterostructures) with lateral random potential fluctuations of a large scale has been investigated. The properties of interwell excitons whose photoexcited electron and hole are spatially separated in the neighboring quantum wells were studied as a function of density, magnetic field and temperature down to 0.5K within domains (macroscopic lateral traps for interwell excitons) on the scale around one micron and less. For weak pumping and low temperature excitons are strongly localized due to potential fluctuations connected with residual impurities, and the corresponding photoluminescence line is inhomogeneously broadened (up to 2.5 meV). As resonant excitation power increases, the narrow line of delocalized interwell excitons arises in a threshold manner, its intensity sharply superlinearly increases on the pump power, line narrows (FWHM less than 300 μeV), and undergoes a low energy shift (of about 0.5 meV), in accordance with the filling of the lowest state in a domain ($E \to 0$). With increase in temperature, this line disappears from spectrum (T> 4K). The observed phenomenon, which is critical to exciton density and temperature, is attributed to the bose-condensation in laterally confined quasi-two dimensional system of interwell exciton. In the studied temperature range (0.5 – 4 K), the critical exciton density and temperature increase in a linear power low manner, corresponding phase diagram was constructed in coordinates $N_C - T_C$. The same collective phenomenon was observed under condition of lateral confinement of interwell excitons in a strongly inhomogeneos electrical field created with the use of a tip of tunneling microscope. It was found that that magnetic field perpendicular to quantum well planes strongly reduces critical temperature of interwell exciton condensation. Kinetics of interwell exciton luminescence spectra and time evolution of collective exciton phase under pulse laser excitation has been studied. Exhibition of coherent properties of collective exciton phase is discussed.