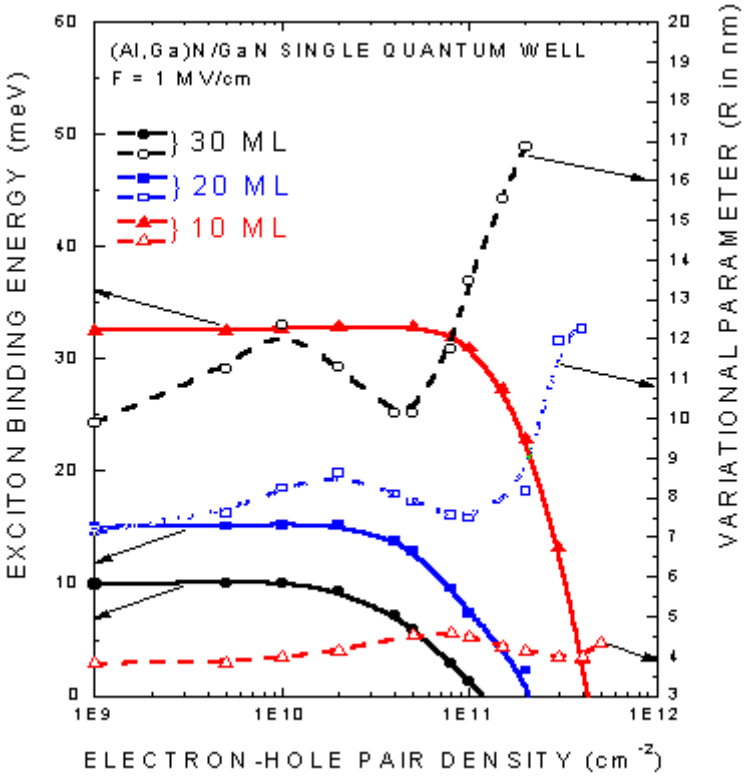
Excitons in GaN/GaAlN quantum wells: optical puming and temperature effect

A.Kavokin[1], P. Bigenwald[2], B. Gil[3] and P. Lefebvre[3]

[1]*LASMEA, Université Blaise PASCAL, 24 Avenue des Landais, 63177 AUBIERE, FRANCE*
[2]*Dpt de Physique - UFR Sciences, 33, rue PASTEUR, 84000 AVIGNON, FRANCE*
[3]*GES, Université Montpellier II, Place Eugène Bataillon, 34095 MONTPELLIER, FRANCE*

We have studied theoretically the combined effect of carrier photo-injection intensity ( ) and temperature (T) on the exciton properties of AlGaN/GaN single quantum wells. The adopted variational approach has allowed to take into account both bleaching and exclusion effects in the interaction of excitons with an electron-hole plasma. Due to the internal polarization fields, the initial exciton parameters are greatly reduced compared to the flat band case. The filling of the bands by carriers smoothes the potentials, makes the recombination of electrons and holes easier thus increasing the exciton oscillator strength and binding energy. On the other hand, the pumping increase induces the increase of the kinetic energy of the exciton which is dependent on the Fermi energy: this leads to the shrinkage of the exciton binding energy (E_b) and the corresponding increase of the Bohr radius (R_B). The two competing effects are investigated quantitatively, and we show that different regimes may be observed in selected SQWs depending on the well width and the polarization field (see the figure). We show in particular, that, in a limited range of , E_b is quasi-independent of the pumping intensity while at some critical puming value it starts to decrease rapidly [1]. We show that the temperature increase reduces the bleaching of the excitons for large values of . Moreover, the temperature increase relaxes the limitations imposed by the Pauli principle on the exciton wave-function, so that the exciton kinetic energy decreases and the binding energy increases with the temperature increase.



[1] P. Bigenwald, A. Kavokin, B. Gil, P. Lefebvre, Phys. Rev. B, in press (2000).