Micro-photoluminiscence from InAs/GaAs quantum dot pairs and molecules grown by droplet epitaxy

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We have investigated electric field dependence emission properties of single InGaAs/GaAs quantum dot pairs and molecules. These nanostructures were grown by droplet epitaxy [1]. This growth technique results in the formation of nanoholes where in-plane laterally aligned pairs of quantum dots (QDs) can be nucleated using the appropriate growth conditions. Compared with purely self-assembled methods, the droplet epitaxy technique allows to control separately the emission energy and nucleation density and produces good optical properties at the single QD level [2]. We have fabricated lateral electric field Schottky devices that allow to tune the energy levels of both QD and produce molecular coupling. We have found three different micro-photoluminiscence (micro-PL) pictures, attached to single QD, QD pair (not coupled) and QD molecule (coupled) systems. Single QD picture is related to the 2% of possibilities to obtain only one QD at each nanohole. QD pair micro-PL evolution was found when distance between both QDs is too large to produce strong molecular coupling. Finally, it was found asymmetrical micro-PL features (figure 1) which are in good correspondence with theoretical framework based on full CI (Configuration Interaction) calculations and effective mass approximations. Although clear anticrossing optical signatures were not identified, this signature of lateral molecular coupling is not easily found in literature [3, 4], the asymmetric Coulomb blockade QD charging and Stark effect gives valuable information to confirm the molecular coupled system [5].

References:

[1] P. Alonso-González, J. Martín-Sánchez, Y. González, B. Alén, D. Fuster, and L. González. Crystal Growth and Design 9 (2009) 2525 (2009).

[2] P. Alonso-González, B. Alén, D. Fuster, Y. González, L. González, J. Martínez-Pastor. Appl Phys Lett 91 (2007) 163104 .

[3] E. A. Stinaff , M. Scheibner, A. S. Bracker, I. V. Ponomarev, V. L. Korenev, M. E. Ware, M. F. Doty, T. L. Reinecke, D. Gammon. Science 311 (2006) 636 .

[4] H. J. Krenner, K. Mueller, C. Lienau, T. Elsaesser, A. D. Wieck. Phys Rev Lett 94 (2005) 057402 .

[5] J. Peng, C Hermannstädter, M Witzany, M Heldmaier, L Wang, S Kiravittaya, A Rastelli, O G. Schmidt, P Michler, G Bester, arXiv: 0910.5138v1 (2009).

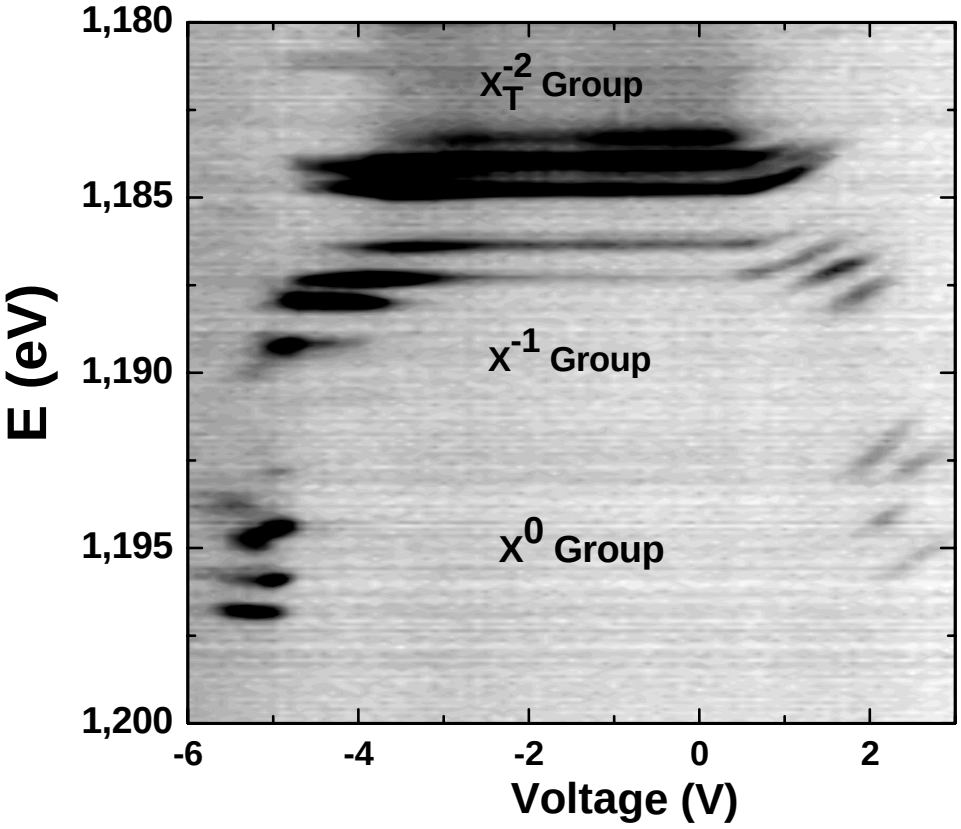

Figure 1. Voltage dependence sweep of the micro-PL from a coupled QD pair system.