Physics of magnetism in GaN doped with transition metals

Alberta Bonanni[1]

[1] *Institut für Halbleiter- und Festkörperphysik, Johannes Kepler University, Linz - Austria*

We summarise here our work aiming at elucidating the physics of magnetism in the two dilute magnetic semiconductors (Ga,Mn)N and (Ga,Fe)N and at demonstrating the unanticipated effects of the co-doping of these systems with donors (Si) and acceptors (Mg). According to our experimental and theoretical studies, the ferromagnetism of (Ga,Mn)N is driven by ferromagnetic superexchange between diluted Mn^{3+} ions [1]. Here the co-doping with Si results in Mn^{2+}, whose coupling is antiferromagnetic, whereas Mg co-doping leads to the formation of Mn-Mg_k complexes that show room temperature luminescence relevant for optoelectronic applications [2]. In contrast to Mn, the Fe cations aggregate at the growth surface, a process that can be controlled by Si and Mg co-doping, as observed experimentally and confirmed by *ab initio* studies [3]. This aggregation accounts for the formation of either ferromagnetic or antiferromagnetic Fe-rich nanocrystals, whose position can be predefined by the structure design and growth conditions [3,4].

References:

[1] A. Bonanni, M. Sawicki, T. Devillers, W. Stefanowicz, B. Faina, Tian Li, T. E. Winkler, D. Sztenkiel, A. Navarro-Quezada, M. Rovezzi, R. Jakiela, A. Meingast, G. Kothleitner, and T. Dietl, *Phys. Rev. B* **84**, 035206 (2011); S. Stefanowicz, G. Kunert, C. Simserides, J. A. Majewski, W. Stefanowicz, C. Kruse, S. Figge, Tian Li, R. Jakieła, K. N. Trohidou, A. Bonanni, D. Hommel, M. Sawicki, and T. Dietl, *Phys. Rev. B* **88**, 081201(R) (2013).

[2] T. Devillers, M. Rovezzi, N. Gonzalez Szwacki, S. Dobkowska, D. Sztenkiel, A. Grois, J. Suffczynski, A. Navarro-Quezada, B. Faina, Tian Li, P. Glatzel, F. d'Acapito, R. Jakiela, M. Sawicki, J. A. Majewski, T. Dietl and A. Bonanni, Scientific Reports 2, 722, (2012) ; T. Devillers, D. M. G. Leite, J. H. Dias da Silva, and A. Bonanni, *Appl. Phys. Lett.* **103**, 211909 (2013).

[3] A. Navarro-Quezada, N. Gonzalez Szwacki, W. Stefanowicz, Tian Li, A. Grois, T. Devillers, M. Rovezzi, R. Jakieła, B. Faina, J. A. Majewski, M. Sawicki, T. Dietl, and A. Bonanni, *Phys. Rev. B* **84**, 155321 (2011); I. A. Kowalik, A. Persson, M.A. Nino, A. Navarro-Quezada, B. Faina, A. Bonanni, T. Dietl, D. Arvanitis, *Phys. Rev. B* **85**, 184411 (2012).

[4] A. Navarro-Quezada, T. Devillers, Tian Li, and A. Bonanni, *Appl. Phys. Lett.* **101**, 081911 (2012).