Nanoscale inhomogeneities in diluted magnetic systems : Effects on Curie temperature and spontaneous magnetization

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The presence of nanoscale inhomogeneities has been experimentally evidenced in several diluted magnetic systems, which in turn often leads to interesting physical phenomena. Among them room-temperature ferromagnetism is one of the most interesting and sought after topics in today's emerging field of spintronics. However, until now, in the dilute regime it has been difficult to obtain Curie temperatures larger than that measured in well annealed samples of (Ga,Mn)As (~190K for 12% doping). Here we suggest an innovative path to room-temperature ferromagnetism in diluted magnetic semiconductors. We theoretically show that even a small concentration of nanoscale inhomogeneities can result in a gigantic increase of the critical temperatures [1]. We give a plausible explanation for the wide variation of the critical temperatures measured in (Ga,Mn)N and provide a better understanding of the likely origin of very high Curie temperatures measured occasionally. We also show that nano-sized clusters of magnetic impurities can lead to drastic effects on the temperature dependent magnetization compared to that of homogeneously diluted compounds [2]. The unusual and unconventional nature of the magnetization curves is found to strongly depend on the relative concentration of the inhomogeneities as well as the effective range of the exchange interactions.

[1] A. Chakraborty, R. Bouzerar, S. Kettemann, and G. Bouzerar, *Nanoscale inhomogeneities: A new path toward high Curie temperature ferromagnetism in diluted materials*, Phys. Rev. B **85** 014201 (2012).
[2] A. Chakraborty, P. Wenk, R. Bouzerar, and G. Bouzerar, *Spontaneous magnetizationin in presence of nanoscale inhomogeneities in diluted magnetic systems,* (submitted to Phys. Rev. B).