X-ray absorption fine structure approach in the study of diluted magnetic semiconductors

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Semiconductors doped with magnetic ions (DMS) are promising materials for applications in the emerging field of spin-electronics. To attend this challenge, a relative high amount of magnetic impurities should enter the host crystal structure without phase separation. X-ray absorption fine structure is a well suited short-range order probing technique to understand the underlying mechanisms responsible for the special physical properties of these materials. The starting point of this study are historical (II,Mn)VI DMS showing good Mn incorporation in substutional sites up to relatively high concentrations and the well known GaAs doped with Mn deposited in non-equilibrium conditions (low-temperature molecular-beam epitaxy) where the creation of Mn interstitial defects reduce the ferromagnetic transition temperature. In the same family Mn-catalized GaAs nanowires should bring DMS to 1D devices but at the moment only the appearance of Mn-As bonds is reported. A new promising material is Fe-doped GaN showing interesting magnetic properties when doped around solubility limit. In this case a key role is the transition from Fe substitutional to the precipitation of Fe-rich nanocrystals in the conditions of spinodal decomposition. This phenomenon is also responsible for high Curie temperature in Mn-rich nanocolumns in Ge where understanding local structure around Mn is a demanding job.