


Internship proposal 2011-2012

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Electronic states of single magnetic dopants in semiconductors

Scientific project : Individual Mn acceptor in GaMnAsP will be probed by Low Temperature Scanning Tunnelling Microscopy and Spectroscopy (STM and STS). This approach has been already applied to determine the acceptor state level in the band gap of GaMnAs [Kitchen Nature 2006]. After cleavage under UHV conditions of samples grown by Molecular Beam Epitaxy (MBE) at the LPN, we will be able to image by STM clean cross sectional (110) surfaces of GaMnAsP. The concentration of Mn will be optimized for this study in order to be able to image single ions in the GaAsP matrix. A particular effort will be devoted to identify Mn and P atoms. The imaging in topographic mode and spectroscopic mode of single Mn ions, which gives a mapping of the local electronic density of state, will characterize the hybridization of the impurity state with the matrix [Jancu PRL2008]. Then, $I(V)$ and $dI/dV(V)$ spectra measured with the STM tip on top of an individual Mn ion will characterize the energy level of the Mn acceptor state within the semiconductor gap: for a localized state such as acceptor level, differential conductance spectra show a peak within the gap. The acceptor level of Mn atoms will be studied as a function of the local variation of the potential landscape due to additional P atoms. Finally, the analysis of such acceptor level can also be realized for different pair configuration such as (Mn-Mn) and (Mn-P) as a function of relative distance and crystallographic orientation between the pairs atoms. This might indicate the nature and strength of the interaction between two magnetic atoms and therefore the local cause of ferromagnetism in the material. The comparison between results on GaMnAs and GaMnAsP will allow determining the specificity of the latter and the influence of the P doping for to local transport and magnetic properties.

Techniques in use :

Low Temperature Scanning Tunnelling Microscopy and Spectroscopy (STM and STS)

Applicant skills :

Theoretical background in semiconductors and interest for experimental physics

Granted internship : yes (417 €/month)

C'nano IdF laboratory (France only) : yes

Possibility for a thesis: yes (type of grant : from Ministry of Research)