2019-2020

Master thesis proposal

Centre de Nanosciences & de Nanotechnologies
C2N
10 bd Thomas Gobert
91120 Palaiseau
Director: Giancarlo Faini

Title: "Atomic manipulation and scanning tunneling spectroscopy of magnetic atoms in II-VI semiconductors."

Keywords: STM/STS, semiconductors, spin

Scientific description:

Magnetic Chromium (Cr) incorporated in semiconductors is strongly sensitive to lattice deformation, a property that can be employed to develop systems with large intrinsic spin to strain interaction. This internship is supported by an ANR project: *MechaSpin* (Institut Neel, INAC and C2N partners) that will explore the potential of using the spin of an individual Cr atom in a semiconductor quantum dot as an optically addressable *qubit* for hybrid spin-mechanical systems.
At C2N, we use cross-sectional STM (X-STM) to address single dopants in semiconductors. Using this method, we observed the hybridization of impurity and surface states of single Mn dopants in GaAs [*Jancu et al* PRL 2008] and demonstrated STM tip assisted substitution of individual Cr atoms in GaAs [see Figure1, *Badiane* PhD 2017]. So far, the deterministic positioning, the implantation and the spectroscopy of individual magnetic atoms have not been explored in II-VI semiconductors. STM tip-assisted substitution of Cr in II-VI semiconductors will be explored experimentally to probe the interaction of the inserted atoms with their local environment and modelled with *ab initio* calculations. This study will permit to identify the favorable experimental conditions enabling atom-by-atom substitution and this in order to provide a realistic approach to create precise arrangements of single spins in semiconductors. The intern student will also have the opportunity to be involved in the development of the emerging method of ESR-STM enabling measurements of the resonant spin-excitation spectrum of single spins.

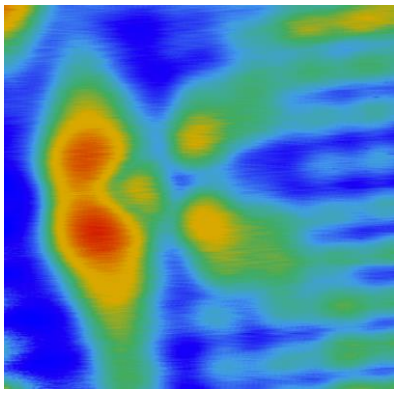

Figure 1: *STM image (3nm x 3nm, -1.5V, T=4K) of a single Cr atom incorporated by the STM tip in a Ga position on the first plane of the GaAs(110) surface.*

Techniques/methods in use: cross-sectional STM (X-STM)
Applicant skills: Solid states physics
Industrial partnership: No

Internship supervisor(s)
Jean-Christophe Girard, jean-christophe.girard@c2n.upsaclay.fr, 01 70 27 05 45
and Guillemin Rodary, guillemin.rodary@c2n.upsaclay.fr , 01 70 27 05 00
https://phynano.c2n.universite-paris-saclay.fr/en/teams/stm-sts/

Internship location: C2N, Palaiseau

Possibility for a Doctoral thesis: Y (not yet financed)