Internship offered in M2
2018-2019

Responsible for internship

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Internship topic: High resolution resonant spectroscopy of NV Centers in Silicon Carbide for quantum computing

Quantum computing is based upon quantum properties of matter, like superposed and entangled states. It has been shown recently that point defects in solid may be considered as relevant elementary quantum systems in this frame. At INSP, the 'Couches Nanométriques : Formation, Interfaces, Défauts' (CONFID) team has achieved the identification of a very promising defect in silicon carbide, a semiconductor which has already many applications in microelectronics. This defect is called NV center and is formed by a nitrogen – silicon vacancy complex (N is used as a dopant atom in SiC). The team has determined by electronic spin resonance under optical excitation, the magneto optical properties of this defect and experimental results have been compared to theoretical calculations made in collaboration with the university of Paderborn (Germany) to establish the defect structure, at the atomic scale.

In diamond, negatively charged carbon vacancy- nitrogen close pairs (N_CV_C) , the so-called NV centers, have shown to be exceptional candidates for application as solid-state qubits but also for localized nano-sensing of magnetic fields and nano-thermometry. Due to the superior material properties of silicon carbide, a mature microelectronic material applied in high frequency and high power devices, NV centers in SiC can be expected to be challenging competitors for such applications

NV centers in SiC have magneto-optical properties similar to those of NV centers in diamond with a spin S = 1 ground state (GS), a spin S = 1 excited state (ES) and an intermediate singlet state (IS). The optical transitions between these levels are in the infra red domain whereas microwave can induced spin state modification. In SiC, different crystallographic configurations of the nitrogen – silicon vacancy complex with slightly different spectroscopic characteristics do exist. In this study we propose a new approach

for linking infra red emission lines directly with atomic configurations of the NV centers. This method combining electron paramagnetic resonance spectroscopy and high resolution resonant optical excitation should find wide application in the field of solid state qubits in semiconductors.

For more information :

1.Quantum technologies with optically interfaced solid-state spins
David D. Awschalom, Ronald Hanson, Jörg Wrachtrup and Brian B. Zhou
Nature Photonics 12, 516 (2018)

2. H. J. Von Bardeleben, J. L. Cantin, E. Rauls, and U. Gerstmann,
Physical Review B 92, 064104 (2015).

3. S. A. Zargaleh, B. Eble, S. Hameau, J. L. Cantin, L. Legrand, M. Bernard, F. Margaillan, J.S. Lauret, J. F. Roch, H. J. Von Bardeleben, E. Rauls, U. Gerstmann, and F. Treussart,
Physical Review B 94, 060102 (2016).

4. H. J. Von Bardeleben, J. L. Cantin, A. Csóré, A. Gali, E. Rauls, and U. Gerstmann, Physical Review B 94, 121202 (2016).

5. A. Csóré, H. J. Von Bardeleben, J. L. Cantin, and A. Gali,
Physical Review B 96, 085204 (2017).

Techniques involved: electron spin resonance spectroscopy, infrared optical spectroscopy, low temperature measurements

Type of internship: experimental
Paid internship: Yes/No
Can this internship be continued for a PhD? Yes
If yes, type of PhD funding envisaged is: to be found

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