Institut des Nanotechnologies de Lyon UMR CNRS 5270
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PhD Grants from the China Scholarship Council
Proposal from INL / INSA de Lyon
June 26th, 2014

Title : Fabrication and Characterization of Nanodevices
realized by Atomic Force Microscope Nanolithography

Context
A tremendous research effort has been undergone since the late 90’s to study Emerging Research Devices (ERDs) and evaluate their respective prospects. Nowadays the consensus is that the aim of these technologies is not to replace CMOS but to complement it. Among the ERDs, we are particularly interested in two kinds of devices:
- Single Electron Transistors (SETs), which belong to the field of nanoelectronics, are a kind of devices that specifically features a low power consumption and addresses the increase of power dissipation issue. Although these devices are known since the end of 1980s, there are very few fabricated SETs that are working at room temperature with reproducible characteristics.
- Resistive switching memories (RRAM or memristors), which belongs to the field of non volatile memories, for which a first experimental evidence came up in 2008. Both devices may share a metal-insulator-metal (MIM) configuration as building block involving identical materials.

PhD subject
The subject proposed here belongs to one major research axis of INL, which concerns advanced nanoelectronic components. The goal is to contribute to the development at the INL of nanodevices using Atomic Force Microscope Nanolithography. This technology will be implemented for the realization of Single Electron Devices (SED) or Resistive switching Memories (RRAM).
The fabrication of nano devices relies on the oxidation using AFM. In a humidity-controlled environment, the application of an appropriate bias voltage on the AFM tip induces an electrochemical reaction in the water meniscus under the tip that causes the oxide growth. This technology enables to decrease lateral dimensions of the electronic components in the best case up to a few nanometers. This technology will be preferentially implemented to metallic (Ti, Al, TiN...) layers,
micro- and nanowires to realize devices of increasing complexity. The PhD candidate will be involved in the following tasks:

- Clean room work for device processing in the NanoLyon Platform (facilities including optical and ebeam lithography)
- Nanolithography using AFM
- Electrical characterization at the device level (C-V and I-V measurements) and extraction of relevant parameters.

The candidate will be integrated in the Electronic Devices Team of INL and his work will be supervised by assistant professors presenting complementary competences.

Informal collaboration with the international laboratory L2N de Sherbrooke will take place. We also intend to set up research programs to set up collaborations with French and European labs interested in the Atomic Force Microscope based Nanolithography.

**Duration**: 42 months

**Profile**:
The applicant should possess advanced knowledge in the field of electronic components: semiconductor physics, nanoelectronics, nanometric MOS devices, as well as technology of semiconductors and nanocharacterization. Hands-on skills are required regarding device nanofabrication. A preliminary experience in clean-room environment would be greatly appreciated.

**References**

**Laboratory presentation**
The Institut des Nanotechnologies de Lyon INL (inl.cnrs.fr) is a 240 person-strong research institute. It carries out research activities in the field of Nanotechnology, from Materials to circuit design. Its 4 main research axes concern functional materials, electronics, photonics and photovoltaics, biotechnology and health. Facilities include: clean room environment (NanoLyon plateform), device electrical testing, (home-made or commercial), simulation tools...
PhD Supervisors
This work will be performed under the supervision of two supervisors, Dr. Martine Le Berre (research supervisor ability) and Dr. Etienne Puyoo.


