Post doctoral position available at the CEA-LETI. This position is granted by the French National Research Agency (ANR) under the reference PNANO06-0006.

**Topic title:** Dynamic integrated near field tools for organic and molecular electronics

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**Project in collaboration between DRFMC & LETI within the “Chimtronique program” head R. Baptist**

**Keywords:** Tuning fork atomic force microscopy (TF-AFM), ultra-miniature evaporation masks (nanostencils), ultra-high vacuum (UHV), nano-structuration, nano-characterisation, organic electronics, organic semiconductors, nanoscopic organic field effect transistors (nano-OFETs).

**Research project**

The development of advanced forms of near field techniques, which combine under ultra-high vacuum (UHV) the functionalities of imaging, nano-structuring, addressing and electrical characterization, holds the promise of key-advances both for fundamental and technological research (studies of nano-objects physical properties in ultra-clean conditions, development of new nano-characterization, nano-patterning and nano-manipulation tools). Such techniques are particularly suitable for research in the field of molecular and organic electronics. To probe the intrinsic electronic properties of organic materials [B. Grévin & P. Rannou, Nature Materials 3, 503 2004], the in situ electrical connection of nano-objects evaporated under UHV conditions is indeed highly desirable.

This project within the DRFMC, developed in close collaboration between the DRFMC/SPrAM, the LETI/DIHS/LIMN and the DRECAM/SPCSI (CEA-Saclay), is aimed to achieve the combination of nanostencils [M. A. F. van den Boogaart et al J. Vac. Sci. Technol. B 22(6), 3174 (2004)] with atomic force microscopy (AFM) capabilities. The so-called nanostencils consist in ultra-miniature evaporation masks (or “shadow masks”) with mesoscopic and/or nanoscopic apertures, which are used for the deposition of materials with a high degree of localization. **Our goal is to couple the nanostencils with an AFM regulation** [S. Egger et al, Nanoletters (2005) No. 1 15-20], which will pave the way for the in situ connection of nano-objects under UHV.

The dynamic AFM modes operation under UHV, and the coupling of nanostencils with AFM regulation, will be achieved by using rigid piezoelectric actuators also called “tuning forks”. We have acquired these past years a good experience of TF-AFM operation on soft materials [M. Brun et al Appl. Phys. Letters 87, 133101 2005], and compared to the more conventional “beam deflection modes”, it will be easier to drive the nanostencils with a “tuning fork” based AFM. To insure the full coupling of nanostencil and AFM modes, metallic tips will be integrated on the nanostencils (by controlled deposition under FIB).

One of the major goals is to evaporate nanostructures and to achieve AFM images with the same device: the “dynamic Nanostencil-AFM”. When operational, this technique will be used to realize in situ electrical connection on organic mono-domains evaporated on oxides surfaces under UHV, with the aim to probe their intrinsic electronic properties.

The post doctoral collaborator will develop specific SPM modes (TF-AFM under UHV) in order to master the coupling between the nanostencils (provided by the LETI/LIMN team, M. Brun et al.) and the AFM regulation. Operational devices (nano organic field effect transistors) will be realized in situ with the nano-stencil on organic semiconductors thin films with sub-monolayer coverage in collaboration with the chemists (P. Rannou et al.) and physicists who currently develop new routes towards better processing techniques of molecular crystals thin films and are investigating their structural and electronic properties with SPMs techniques (B. Grévin et al.).
This project is funded for 3 years by the National Agency of Research (ANR, http://www.agence-nationale-recherche.fr). Project ONDIEMO B. Grévin (project leader) SPrAM / M. Brun LETI / J. Cousty DRECAM


Figure 2- Left: Tuning fork AFM image of a self-organized PS:PMMA copolymer under high vacuum (M. Brun et al. Appl. Phys. Letters 87, 133101 2005). The top insert display the tuning fork with its glued W tip for TF-AFM operations. Right: concept of the dynamic nanostencil coupled with TF-AFM. DRFMC/SPrAM.

Figure 3- Left: integrated W tip grown under FIB. Middle and Right: mesoscopic and nanoscopic apertures realized on suspended membranes. LETI/DIHS/LIMN.
The following facilities will be available in our laboratory for the project:

- Dynamic nanostencil chamber under ultra-high vacuum with in situ low current STM, tuning fork AFM, XY table in close loop for full operation in AFM coupled-nanostencil mode, and evaporator for metal deposition.
- UHV VT-STM/AFM (30K-900K, Omicron) for complementary SPM investigations, surface analysis (LEED, XPS/UPS) and organic thin films deposition under UHV.
- Facilities for electronic transport measurements on operating devices (semiconductor analyzer and probing station)

The position is for one year with the possibility of renewal for a second year.

Candidates should have a strong experimental background in near field microscopies (AFM and/or STM-based techniques), and if possible a former experience of scanning probe microscopies under ultra-high vacuum. Experience in organic/molecular electronics is not required. Skills in clean room are not required (the nanostencils for this project are already realized by the LETI/LIMN team) but a knowledge of these techniques will be appreciated. Further information about the position can be obtained from Dr M Brun mickael.brun@cea.fr, +33(0)4-3878-3505 or Dr B. Grévin, benjamin.grevin@cea.fr, +33(0)4-3878-4615, fax +33(0)4-3878-5113.

Applications (to be sent to mickael.brun@cea.fr and/or benjamin.grevin@cea.fr) should include a curriculum vitae highlighting the main contributions, a letter in which the applicant highlights his main contributions and motivates his interest for this project, and a complete list of publications with an indication of those which the applicant selects as the most relevant for the application. Reference letters will be given proper consideration.