Sujet de thèse

Laboratoire : CINaM-UMR 7325, http://www.cinam.univ-mrs.fr

Directeur de thèse (Prénom, Nom): Didier TONNEAU
Coordonnées (email, tél): didier.tonneau@univ-amu.fr, 06 29 41 37 81

Co-encadrant: Carole FAUQUET
Coordonnées (email, tél): fauquet@cinam.univ-mrs.fr, 06 29 41 38 10

Sujet (intitulé): **Couplage entre Spectroscopie de RX et Microscopie en Champ Proche**

Thèse en Co-tutelle avec Argonne National Laboratory-Advanced Photon Source (IL, USA - Dr Volker Rose)

Sujet

Scanning Probe Microscopes (SPM) are powerful non-destructive tools for surface topography reaching the ultimate limit of atomic resolution. However, these tools cannot provide direct elemental chemical mapping of the analyzed surface, **which presents a drastic limitation of the technique for actual applications in the field of materials science, and for engineering and processing in industry**.

X-Ray Spectroscopies are powerful analysis techniques allowing to determine chemical and structural properties of a material as well as the atomic environment and the corresponding bond lengths. These techniques are based on the spectroscopy of photons (X-rays or visible) or of photoelectrons, emitted by a surface irradiated by an X-Ray beam. They require a high brightness X-Ray source and are thus better performed in synchrotron environment. The lateral resolution reached for chemical mapping is limited by synchrotron-beam focusing optics. A great effort is now devoted at synchrotrons (APS, Spring8…) to improve the resolution of these techniques and some beamlines now achieve focused primary beams even down to about 30 nm. **However, the analysis is carried out on a non-specific nano object, since no simultaneous surface visualization at the nanometer scale is up to now possible to position the primary beam**.

CINaM and ANL have created a French-US consortium (X-tip) working on instrumental development projects aimed to design and develop a new generation of characterization tools allowing surface topography measurement simultaneously to chemical mapping at high resolution**.** These non- destructive instruments are based on the use of a sharp probe of a SPM microscope to collect at the very proximity of the tip apex either the local X-ray fluorescence [1, 2], or the visible luminescence [3], or the X-ray induced photoelectrons [4, 5].

The work at ANL will be focused on photoelectron collection using an STM (Scanning Tunneling Microscope) tip, while CINaM will combine AFM (Atomic Force Microscope) to XRF (X-ray Fluorescence) analysis. In both cases, the ultimate resolution will be defined from numerical simulations, taking into account the convolution phenomenon

induced by the microscope tip. These results must be compared to those obtained on dedicated sub-micron scale test patterns to be designed.

Is it possible to reach the ultimate sensitivity of single atom detection and characterization?

Références bibliographiques:

[1] M. Dehlinger, C. Fauquet, S. Lavandier, D. Tonneau
Nanoscale Research Letters **8**: 271 (2013).

[2] M. Dehlinger, C. Fauquet, W. Arkadiev, A. Bjeoumikhov, A. Erko, D. Tonneau
Submitted to Specrochimica Acta B (to be published).

[3] C. Fauquet**,** M. Dehlinger**,** F. Jandard**,** S. Ferrero**,** D. Pailharey**,** S. Larcheri**,** R. Graziola**,** J. Purans**,** A. Bjeoumikhov**,** A. Erko**,** I. Zizak**,** B. Dahmani and D. Tonneau, Nanoscale Research Letters **6**:308 (2011).

[4] A. Saito et al., Japanese J. of Appl. Phys., Vol.45 (3B), 1913-1916 (2006).

[5] V. Rose et al., Appl. Phys. Lett. 92, 193510 (2008).

Application package for the doctoral school PhD grant (AMU quota)

- CV

- Cover letter

- 2 lettres of recommandation

- Copy of diploma

- Marks and ranking since the first University years

To be sent to Prof Didier TONNEAU: Didier.tonneau@univ-amu.fr

Deadline Wednesday, June, 11th, 2014