

## **THz-atom probe tomography : new sample preparation strategies**

*Location: Groupe de Physique des Matériaux (GPM), Saint Etienne du Rouvray (France)*

*<http://gpm.univ-rouen.fr/fr>*

*Duration : 15 months, starting autumn 2026*

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The Atom Probe Tomography (APT), the laboratory's flagship technique, enables the 3D reconstruction of the chemical distribution of a nano-object, with spatial resolution close to the atomic scale, using field evaporation of ions from the surface. In laser-assisted APT, commonly used to study metals, insulators and semiconductors, evaporation is triggered by an ultrafast laser pulse in the near ultraviolet (UV) range. The energy of the UV pulses is absorbed by the sample and its heating degrades the instrument's performance in terms of spatial and chemical resolution.

Remarkable progress has been made using sources in the terahertz (THz) range, which has enabled the analysis of metallic materials as well as ceramics and oxides. In addition, it has been shown that the emission process assisted by THz pulses minimizes heating effects. An important parameter for APT analyses is the repetition rate of laser sources. High-frequency sources (>100kHz) enable large volumes to be analyzed using APT. However, in the THz domain, high-frequency sources are less energetic than low-frequency sources. This can reduce their effectiveness when used in APT.

Recent high-repetition-rate results show that THz pulses can be used to analyze metals with performance superior to that of commercial APT. However, for sol-gel silica sample or more generally for insulating materials, high-repetition-rate THz pulses of a few hundred kV/cm no longer reach the intensity required for APT analysis.

This project aims to explore original approaches to overcome the current limitations of THz pulse-assisted APT. The first way focuses on the development of a new, more intense THz source, while the second focuses on amplifying less intense sources by metallizing the sample, or by using metallic matrices.

The post-doc will principally work on the amplification of the THz pulse through the sample itself, via its metallization. We plan to test different metal deposition techniques as well as different types of metals. Preliminary encouraging results have been obtained with chromium metallization on silica and germanium samples, but the adhesion of the metal layer and the quality of the deposition still need improvement. Furthermore, in order to test the performance of the THz-APT technique on biological materials, cryogenic preparation will be required; the metal coating will therefore also be applied at cryogenic temperatures. To analyse these biological materials, the postdoctoral researcher will implement new sample preparation techniques, such as encapsulating biological materials in metal matrices (Au, Cu, Ag) containing nanopores. The metal matrix will allow for better amplification of the THz field and thus improved analysis of the biomaterials.

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**Work Program:**

The postdoctoral researcher will test metal deposits, starting with silver — chosen for its high electronic mobility — on samples with low electrical conductivity (such as silica and cholesterol), at room temperature and at cryogenic temperatures, depending on the materials' sensitivity to the electron beam during shaping by a focused ion beam.

The second strategy to be tested involves using porous metal matrices, which will be filled with materials of low electrical conductivity (sol-gel silica and/or cholesterol) and then shaped into nanoneedles.

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**Collaborations:**

This study will be conducted in collaboration with the Optical and Laser team at the CORIA laboratory.

**Skills:**

- Strong knowledge in condensed matter physics
- Previous experience with atom probe microscopy is highly desirable.
- Technical skills required in electron microscopy and/or atom probe tomography
- Independent work
- Team work

**Application:**

The PhD student will be supervised by Prof. Angela Vella.

Interested candidates should send a CV, a letter of motivation and the names of 2-3 references to:

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