



## 3 year- PhD fully funded position at FEMTO-ST Institute

### Ultrafast laser-assisted printing of functional materials

Keywords : femtosecond lasers, ultrafast science, optics, 3D micro-nano printing

#### **Description of the Laboratory:**

**FEMTO-ST institute** ([www.femto-st.fr](http://www.femto-st.fr)) is a multidisciplinary research institute composed of seven departments covering numerous domains of engineering sciences and including more than 500 scientific, administrative and technical support staff. About 225 PhD students receive a high-level training in scientific research. It is one of the most competitive research institutes in France and is among the leaders in the world on Engineering for micro and nanoscale. One of the key research topics at FEMTO-ST Institute is the development of devices based on electroactive materials with particular emphasis on microelectromechanical systems (MEMS), photonics, electro-optics, phononics, acoustics and robotics. FEMTO-ST institute has a microfabrication technology center with clean room facilities MIMENTO mixing technologies from microelectronics to micromechanics. MIMENTO is a member of the national network of seven largest clean rooms in France (RTB).

The PhD thesis will be performed by crossing the expertise of two research groups of FEMTO-ST: PiezoMEMS group in Time & Frequency Department and OPTO group in Optics Department.

**PiezoMEMS group:** The link between research and lead-free piezoelectric industry has been the DNA of FEMTO-ST for more than 60 years, with the development of quartz in metrology and for 30 years with the development of LiNbO<sub>3</sub> devices. Our current team gathers researchers in electronics and instrumentation of resonator metrology, in material science, in modelling and simulations in mechanical and electronic, and in microfabrication of piezoelectric and electronic packaging. Over the past 6 years, our group filed 6 patents, published 100 regular articles, received 8 PhD awards in conferences, a Grand Prix i-PhD (BPI France) and a professor member of the Institut Universitaire de France. PiezoMEMS is the biggest academic user of MIMENTO facilities and world leader of MOCVD growth of LiNbO<sub>3</sub>. For more information you can view our website : <https://teams.femto-st.fr/piezomems/> & <http://members.femto-st.fr/ausrine-bartasyte/>

**OPTO group:** The OPTO group is a large group of more than 30 academics, postdocs and PhD students on different areas of photonics (quantum engineering, artificial intelligence, ultrafast photonics: see team website). The research of the PhD topic will be realized within the team led by François Courvoisier. The team expertise on ultrafast laser-matter interaction, beam shaping, laser materials processing is internationally recognized by more than 70 invited talks at international conferences and an important track-record of funded European project proposals. François Courvoisier is currently heading the 5M€ European project kw-flexiburst and was granted an ERC Consolidator in 2015. His PhD students and postdocs quickly find attractive positions in academia and industry.

#### **Context**

The next generation of micro- and nano- technologies for manufacturing microelectronic, photonic, and electro-mechanical components (MEMS/NEMS) requires processes that are flexible, fast, parallel, and, most importantly, that minimize waste of elements which sourcing is environmentally costly. This requires 3D structuring and 3D heterogeneous co-integration of structural (polymers, glass, metals, Si) and active materials (electrodes,

piezoelectric, magnetic, or electro-optic materials,.) at micron- and sub-micron scales. However, most of conventional micro-fabrication techniques are based on 2.5D wafer processing (deposition of the active materials layers and structuring using different lithography and dry/wet etching techniques). Additive fabrication of electro-active materials by conventional 3D printing technologies is still under development and offers very limited resolution of tens of  $\mu\text{m}$ . Two-photon lithography, yet with sub-micron resolution is limited to 3D polymer structures.

The PhD thesis belongs to a wider scale project, Nanofutur, funded via the French Excellence funding Equipex+. The goal of this research is the development of a new micro-nanofabrication technique that will answer the needs for flexible micro-nanofabrication in 3D with high throughput. The concept is based on femtosecond laser-controlled chemical deposition of materials, close to laser-activated CVD.

The developments will be done by joining the expertise in CVD and functional materials of the Time-Frequency Department with the expertise in optical design and laser-matter interaction of the Optics Department. The challenges are: 1/ the development of an advanced platform including a reaction chamber and in-situ optical characterization 2/selection of precursor molecules which photolysis yield a high spatial selectivity.

**PhD objectives**

- Design and mounting up the optical setup and reactor chamber.
- Study of precursor photoysis and material growth.
- characterization of the produced materials using state-of the art characterization techniques available at FEMTO-ST.

**Starting date:** September 2024 (latest starting date **October 2024**)

PhD supervisors : Prof. Ausrine Bartasyte & François Courvoisier, Research Director

**Offer requirements**

**Education level:** Master degree or equivalent in Material science /Physics/Engineering, which formally entitle to embark on a doctorate;

**Qualifications & experience:**

- Fluent English (oral and written);
- Background in optics
- Background and expertise in the field of Physics/Material Science and/or Engineering;
- Excellent IT skills (Python, Matlab or Labview programming, Microsoft office, image editors);
- Experience in clean-room, laser fabrication or microfabrication (optional)

**Personal skills:**

The candidate should have a high motivation, excellent interpersonal, time and stress management, and excellent verbal and written communication skills.

**How to apply :**

CV, motivation letter, recommendation letter from Master supervisor, official transcripts of master (1st and 2nd year) and bachelor/license records and rankings (including total number of students in cursus) have to be emailed to [ausrine.bartasyte@univ-fcomte.fr](mailto:ausrine.bartasyte@univ-fcomte.fr) and [francois.courvoisier@femto-st.fr](mailto:francois.courvoisier@femto-st.fr)

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