Laboratoire Hubert Curien
UMR • CNRS • 5516 • Saint-Étienne

Postdoc Position

Ultrafast laser nanostructuring of titanium implant surfaces for dual antibacterial / biocompatible nanopatterns

A postdoctoral position is available for 24 months at Laboratoire Hubert Curien (LabHC) in Saint-Étienne, France. The postdoc will work in the framework of the **BLAST** project ("Fighting Bacteria with ultrafast LAser fabrication of sharp nanoSTructured surfaces"), funded by the French National Research Agency (ANR, appel à projets générique AAPG2025, PRC scheme). BLAST is a 48-month collaboration coordinated by Dr. Virginie Dumas (LTDS, École Centrale de Lyon) and gathering LabHC (Université Jean Monnet – CNRS) and SAINBIOSE (Université Jean Monnet – INSERM). LabHC is jointly run by the CNRS (French National Center for Scientific Research) and Jean Monnet University.

Objectives

The postdoc will lead the experimental effort of Work Package 1, aiming to control, by femtosecond laser processing, a diverse array of self-organized nanopatterns on titanium alloy (Ti6Al4V) surfaces of medical interest. The objective is twofold: engineer a mechano-antibacterial surface covered with high-aspect-ratio nanospikes (typically 20-200 nm wide, 100-600 nm high, density ~100 peaks/µm²) able to perforate bacterial cell walls, while preserving or enhancing the biocompatibility required for implant integration. This dual antibacterial and biocompatible functionality, obtained with a single femtosecond laser process, is the central challenge of BLAST.

Research Program

The work is organized around two main axes:

- **Laser process and polarization shaping.** Nanopattern morphology (nanopeaks, nanobumps, nanocavities) will be controlled through a temporally shaped polarization strategy, combining circular polarization and crossed-polarized pulses delayed via a Mach-Zehnder interferometric setup (delays of 5 to 30 ps), together with fluence, pulse duration, pulse number and wavelength. Surfaces will be systematically characterized by AFM (Bruker ICON) and SEM (JEOL IT800SHL) to establish the correlation between laser parameters and nano-topographic dimensions (density, aspect ratio, morphology).
- **Upscaling and coupling to simulation.** Selected regimes will be reproduced uniformly over large surfaces using a galvano-scanner. 3D FDTD electromagnetic simulations developed at LabHC will be used to compute the spatio-temporal laser intensity distribution on the corrugated, time-evolving surface and to optimize coupling efficiency in multipulse regimes. The postdoc will also feed surface parameters into a physics-guided machine learning model developed within the project, aimed at predicting the laser conditions required for a targeted nanopattern.

Scientific Context

Antibiotic resistance is a rising public health concern, motivating physical, chemistry-free routes to antibacterial surfaces. LabHC recently demonstrated ultrafast-laser-induced nanopeaks on metals with the highest aspect

ratio reported to date, opening a route to biomimetic mechano-bactericidal topographies inspired by insect wings. BLAST builds a full process chain, from laser nanoengineering (WP1, LabHC/LTDS) to advanced topography characterization (WP2, LTDS/LabHC/SAINBIOSE) and biological validation against bacteria and human cells (WP3-WP5, SAINBIOSE/LTDS). The postdoc will be embedded in WP1, the foundational work package supplying nanopatterned Ti6Al4V surfaces to the rest of the consortium, and will interact regularly with the LTDS (Lyon) and SAINBIOSE (Saint-Étienne) partners.

Keywords: Femtosecond laser, ultrafast laser-matter interaction, LIPSS, polarization shaping, nanostructuring, titanium alloy, antibacterial surfaces, biomimetic implants, AFM

Qualifications

We are seeking a highly motivated candidate with an experimental background in ultrafast laser-matter interaction or laser surface engineering. The candidate should:

- Hold a PhD in physics, materials science, optics/photonics or a closely related field.
- Have hands-on experience with ultrafast laser processing and optical setups (interferometry, polarization control).
- Have experience with surface characterization techniques (AFM and/or SEM).
- Experience with electromagnetic simulations (FDTD) or with data analysis/programming (Python, Matlab) is an asset.
- Have a record of peer-reviewed publications in laser-matter interaction, nanophotonics or surface engineering.
- Be comfortable working in a collaborative, multi-partner research environment (LabHC, LTDS, SAINBIOSE).

Practical Details

Start date: 1st of January 2027

Duration: 24 months.

Location: Laboratoire Hubert Curien (UMR CNRS 5516), Université Jean Monnet, Saint-Étienne, France. Regular exchanges with LTDS (École Centrale de Lyon) and SAINBIOSE (Saint-Étienne) are anticipated.

Salary: [to confirm – indicative range in line with ANR postdoc scales, ~2,300–2,800 € net/month depending on experience].

How to Apply

Interested candidates should send a CV and an optional short cover letter to:

Prof. Jean-Philippe Colombier & Sedao —jean.philippe.colombier@univ-st-etienne.fr & xxx.sedao@univ-st-etienne.fr

Application deadline: 15th November 2026.