PhD position
Manufacturing full 3D printed electronic devices using 6 axis robots and non-planar AM (Full3D)

Context and work environment

Context. The fabrication of 3D objects embedding electronic functionalities is a rather new research area which relies on the combined development of: i) new manufacturing machines and control strategies, ii) new materials with adapted rheology and functionalities, ii) the design and simulation of new 3D devices with unconventional geometries. Despite the intrinsic complexity of direct devices embedding into a 3D functional object, recent technological survey reports highlighted devices integration, coupled to additive manufacturing as a high-potential technology expected to deliver a breakthrough application within the next decade.

In this context, the aim of this PhD work is to develop materials, data processing procedures and tools for the additive manufacturing of 3D objects embedding electronic circuits/components or tailored functional structures using industrial 6 axis robots.

The successful development of this manufacturing process would open new opportunities in multiscale manufacturing of functional objects both in terms of freedom of shape, integration of multiple unit operations on a single AM machine leading to unprecedent manufacturing flexibility.

The PhD will be carried out in two Tec21 labs located on the Grenoble Campus:

- LGP2 Laboratory, which has an expertise on LDM additive manufacturing of wood derived materials, conductive inks formulation and the fabrication of 3D electric circuits by using industrial six-axis robots and direct ink writing/piezo jetting;
- 3SR Laboratory, which has an expertise on the Multiphysics modelling of both industrial multiphase systems and as well as their physical/mechanical characterization by coupling X-ray tomography, in situ testing, and 3D kinematical field measurements;

with a minimum 3 months secondment in the ChiLab-ITEM lab of Politecnico di Torino (https://chilabitem.polito.it/,Turin, Italy) which has an expertise on sensors and circuits design/manufacturing by both conventional microelectronics and additive technologies.

Team description: The Ph.D will be carried out under the direction of Dr. Davide Beneventi (LGP2, CNRS), expert in the use of 6 axes robots for e-inks deposition, he supervise the analysis of ink/substrate interactions and process development and Dr. Laurent Orgéas (3SR, CNRS) expert in multiphysics modelling and structure analysis by X-ray tomography, he will supervise the modelling of 3D objects and full device under deformation and mesostructure characterization upon static and cyclic deformation. The secondment in Politecnico di Torino will be supervised by Dr. Valentina Bertana (ChiLab-ITEM, PoliTo) expert in the design, manufacturing and packaging of electronic devices and sensors by both conventional and additive technologies.

The research team will be also composed of 5 researchers: Dr. Olga Stamati (3SR, CNRS), Dr. Jeremie Viguié (LGP2, Grenoble-INP), Dr. Aurore Denneulin (LGP2, Grenoble-INP) and Prof. Luciano Scaltrito (ChiLab-ITEM, PoliTo).

This recruitment takes place within the PhD@Tec21 Programme, which is co-funded as part of the Marie Skłodowska-Curie COFUND actions under the grant agreement #101217261. The recruitment process follows a specific selection and evaluation procedure with particular eligibility criteria, all of which are detailed in the applicant guide available on PhD@Tec21 Website.

Mission and main activities

Manufacturing full 3D printed electronic devices using 6 axis robots and non-planar AM (Full3D)
Description of the project. The Full3D project aims to develop a novel additive manufacturing process using six-axis industrial robots to create 3D printed electronic devices directly embedded within soft or rigid structures. Its main goal is to establish an integrated approach that combines material science, digital design, multiphysics modeling and robotic fabrication to produce multifunctional, deformable, and structurally integrated electronic systems. The project will start with a comprehensive survey of the current state of materials, processes, and applications related to 3D electronics. Building on this groundwork, the research activity will focus on identifying and characterizing suitable electronic inks. Their rheological, electrical, and mechanical behaviors will be systematically investigated to ensure compatibility with additive manufacturing techniques like fused deposition modeling (FDM), CerAM, and additive manufacturing of electronics (AME). The outcome is the selection of optimized ink–substrate pairs that can be combined in reliable, functional 3D systems. In parallel, multiphysics modeling will be employed to predict how printed structures deform and how their electrical performance evolves under mechanical stress. Using simulation tools, the project will explore the relationship between material properties, geometric design, and printing parameters. These numerical models will be validated through experimental studies involving 3D scanning, X-ray microtomography, and digital volume correlation, establishing robust links between design choices and functional performance. Finally, the project will focus on the development of a complete manufacturing process, integrating multi-material printing and robotic deposition of electronic inks. By combining embedded printing and surface printing strategies, the team aims to fabricate demonstrators such as soft robotic grippers, dampers, and piezoelectric actuators with integrated sensing or energy-harvesting capabilities. The resulting methodology will define a comprehensive design–simulation–fabrication framework, enabling rapid prototyping of next-generation embedded electronic devices. Through this interdisciplinary effort, Full3D will deliver a modular robotic additive manufacturing platform that merges mechanical flexibility with embedded electronic functionality, paving the way for future smart materials and adaptive 3D systems. ***Possible research axes.*** 1. Ink–Substrate Interaction and Processability 2. Design and Multiphysics modelling of 3D electric/electronic devices 3. Robotic Additive Manufacturing Process Development
Supervisors: Dr. D. Beneventi (CNRS), Dr. L. Orgeas (CNRS), Dr. Valentina Bertana (PoliTo).
Research fields: Materials Science, Multiphysics Modelling, Printed Electronics, Industrial Robotics/automation
Possible secondments (industrial or academic partners): ChiLab-ITEM lab of Politecnico di Torino (https://chilabitem.polito.it/, Turin, Italy).
Doctoral school: I-MEP2: Engineering - Materials, mechanics, environment, energy, processes, production

Desired profile and expected skills

Education, diplomas. The ideal candidate should hold a Master's degree (or equivalent) in Engineering or Applied Sciences with a strong background in one or more of the following fields:

- Materials Science and Engineering, Polymer Engineering, or Chemical Engineering, with knowledge of rheology, surface interactions, or materials characterization.

- Additive Manufacturing, Mechanical or Industrial Engineering, focusing on 3D printing processes, machine design, or process optimization.
- Robotics and Automation Engineering, with experience in motion control, tool path planning, or multi-axis robotic systems.
- Electronics or Mechatronics Engineering, particularly in the area of printed, flexible, or embedded electronics.
- Computational Mechanics or Multiphysics Simulation, with skills in finite element modeling (e.g., COMSOL, ANSYS) and materials–structure interaction.

Disciplinary skills, experience. Strong experimental and analytical skills, interest in interdisciplinary research and the ability to work across materials, mechanics, and robotics domains are essential. Experience with additive manufacturing equipment, electronic ink formulation, or robotic control software (Rhino/Grasshopper, Val3, or similar) will be considered an advantage.

Personal skills: The project requires adaptability to multidisciplinary challenges, good organizational and time management abilities and strong communication skills to collaborate with different research teams and for results dissemination. Candidate's key assets for success in this project are strong scientific curiosity and motivation to work at the interface of materials science, electronics, and robotics together with a proactive attitude, perseverance, and openness to learning new methods. The candidate should be capable of working independently and creatively, with excellent analytical and problem-solving skills and a high precision in experimentation and reporting.

Employment benefits and conditions

Université Grenoble Alpes (UGA) is offering a 36-month full-time work contract. In line with the European Commission rules for Marie Skłodowska-Curie grant holders, the remuneration will consist of a gross monthly salary of 2,669 EUR. The estimated net salary to be perceived by the PhD fellow will be between 2,050 and 2,152 EUR[1].

Benefits include:

- Access to a high-quality work environment, including a personal computer, scientific equipment and access to library and shared lab facilities
- Full social security benefits and participation to health insurance
- Access to high-level scientific and inter-sectoral training through 120 hours of doctoral courses and workshops
- Opportunity for 2-month secondments at an academic institution or industrial partner during the 2nd year of the PhD
- A vast choice of networking events and activities within the PhD@Tec21 Programme and through the international network of MSCA fellows
- Access to the UGA International Student Office, to assist the PhD fellows in searching for accommodation in Grenoble and support with administrative issues including visas, health, bank accounts, etc.
- Visa fees and registration to the UGA Doctoral School are covered by PhD@Tec21
- Sick leave, parental leave, 45 days of paid holidays

General information

Contact for the questions related to the position:

PhD@Tec21 Management Board: guillaume.chambon@inrae.fr / amelie.bataille@univ-grenoble-alpes.fr

[1] As an average over the 3 years, depending on French tax regulations. Fellows might benefit from an additional allowance depending on their family situation (74 EUR monthly net allowance)