Position Description

1. General Information

Name of the position	**Fatigue behaviour of NiTi architectured materials obtained by additive manufacturing**
Foreseen date of enrolment	1 October 2024
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • École Nationale Supérieure D'Arts et Métiers (ENSAM) • Swinburne University of Technology (SUT)
Research Host	École Nationale Supérieure D'Arts et Métiers
PhD awarding institutions	École Nationale Supérieure D'Arts et Métiers & SUT
Locations	Primary: Bordeaux-Talence, France Secondary: Melbourne, Australia
Supervisors	Prof. Nicolas SAINTIER (ENSAM) A/Prof. Yvonne DURANDET (SUT)
Group of discipline	Mechanics, Materials Science and Engineering

2. Research topics (only one of these projects will be funded)

Project 1: *Effect of process parameters on the microstructure and mechanical behaviour of NiTi alloys*
The superelastic or shape-memory effects of NiTi alloys make them excellent candidates for applications in the transport, space and medical sectors. Superelasticity (SE) allows the alloy to deform reversibly over very large deformation ranges. The shape memory effect (SMA) is the ability of a part to change shape by heating, even after significant deformation, for example actuators that allow the solar panels on satellites to be deployed simply by heating a shape memory part. Applications cover a wide range of fields, from medical applications (stents, endodontic files, flexible glasses) to smart wheels for cars and even in the space industry for the superelastic wheels on the Mars rover. What remains limiting is the difficulty of shaping and machining NiTi alloys, which means that complex shapes are difficult to obtain (production limited to wires and plates). Additive manufacturing makes it possible to manufacture complex parts such as architected structures, producing superelastic or shape memory metamaterials that combine the properties of the material and those of the structures.

This project has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement № 101081465

These structures could find applications in the field of advanced mobility, to absorb shocks or vibrations, or to create deployable structures or customised medical implants. A methodology will be developed to (1) understand the link between the microstructures and the manufacturing parameters, using different microstructure characterisation techniques such as transmission electron microscopy (TEM), scanning electron microscopy (SEM) and electron backscatter diffraction (EBSD), (2) understand the effect of thin walled specimens on the microstructure, (3) understand the quasi-static behaviour of bulk and thin walled specimens in link with the microstructure, (4) to address the cyclic loading response of selected NiTi grades obtained by different process parameters. This project is being carried out jointly by an Australian laboratory, Swinburne University, two French laboratories, I2M and PIMM, and in collaboration with French and Australian industries.
Supervisors: Prof. Nicolas SAINTIER (ENSAM) & A/Prof. Yvonne DURANDET (SUT)
Research Fields: Mechanics, Architectured Materials, Additive Manufacturing, Fatigue, Metallurgy, Microscopy & Microanalysis

Project 2: Combining *shape memory alloys and architectured materials obtained by SLM for high performance mechanical properties*
The superelastic or shape-memory effects of NiTi alloys make them excellent candidates for applications in the transport, space and medical sectors. Superelasticity (SE) allows the alloy to deform reversibly over very large deformation ranges. The shape memory effect (SMA) is the ability of a part to change shape by heating, even after significant deformation, for example actuators that allow the solar panels on satellites to be deployed simply by heating a shape memory part. Applications cover a wide range of fields, from medical applications (stents, endodontic files, flexible glasses) to smart wheels for cars and even in the space industry for the superelastic wheels on the Mars rover. What remains limiting is the difficulty of shaping and machining NiTi alloys, which means that complex shapes are difficult to obtain (production limited to wires and plates). Additive manufacturing makes it possible to manufacture complex parts such as architected structures, producing superelastic or shape memory metamaterials that combine the properties of the material and those of the structures. These structures could find applications in the field of advanced mobility, to absorb shocks or vibrations, or to create deployable structures or customised medical implants. In the case of process parameters leading to a shape memory alloy, a methodology will be developed to (1) understand the microstructures of architectured materials obtained by selective laser meting (SLM) technology using relevant characterisation techniques such as transmission electron microscopy (TEM), scanning electron microscopy (SEM) and electron backscatter diffraction (EBSD); (2) to characterize the quasi-static and fatigue behaviour of lattices structures produced by metallic additive manufacturing (3) to identify the damage mechanisms at the local scale and the link with the microstructure by performing in-situ mechanical testing under synchrotron radiation.
Supervisors: Prof. Nicolas SAINTIER (ENSAM) & A/Prof. Yvonne DURANDET (SUT)
Research Fields: Mechanics, Architectured Materials, Additive Manufacturing, Fatigue, Metallurgy, Shape Memory Alloys

This project has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement Nº 101081465

Project 3: *Superelastics architectured materials obtained by SLM : from microstructure to mechanical properties*
The superelastic or shape-memory effects of NiTi alloys make them excellent candidates for applications in the transport, space and medical sectors. Superelasticity (SE) allows the alloy to deform reversibly over very large deformation ranges. The shape memory effect (SMA) is the ability of a part to change shape by heating, even after significant deformation, for example actuators that allow the solar panels on satellites to be deployed simply by heating a shape memory part. Applications cover a wide range of fields, from medical applications (stents, endodontic files, flexible glasses) to smart wheels for cars and even in the space industry for the superelastic wheels on the Mars rover. What remains limiting is the difficulty of shaping and machining NiTi alloys, which means that complex shapes are difficult to obtain (production limited to wires and plates). Additive manufacturing makes it possible to manufacture complex parts such as architected structures, producing superelastic or shape memory metamaterials that combine the properties of the material and those of the structures. These structures could find applications in the field of advanced mobility, to absorb shocks or vibrations, or to create deployable structures or customised medical implants. In the case of process parameters leading to a superelastic behaviour, a methodology will be developed to (1) understand the microstructures of architectured materials obtained by selective laser meting (SLM) technology using different microstructure characterisation techniques such as transmission electron microscopy (TEM), scanning electron microscopy (SEM) and electron backscatter diffraction(EBSD); (2) to characterize the quasi-static and fatigue behaviour of lattices structures produce by metallic additive manufacturing (3) to identify the damage mechanisms at the local scale and the link with the microstructure by performing in-situ mechanical testing under synchrotron radiation.
Supervisors: Prof. Nicolas SAINTIER (ENSAM) & A/Prof. Yvonne DURANDET (SUT)
Research Fields: Mechanics, Architectured Materials, Additive Manufacturing, Fatigue, Metallurgy, Microscopy & Microanalysis, Superelasticity

3. Employment Benefits and Conditions

The École Nationale Supérieure D'Arts et Metiers (ENSAM) offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). There is a probation period of 3 months and the total working hours per week is 35 hours.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of EUR 23,098.20. Of this amount, the estimated net salary to be perceived by the Researcher is EUR 1,924.85. However, the definite amount to be received by the Researcher is subject to national tax legislation. The % tax cannot be defined in advance with certainty, but will be between 6 and 7% of the monthly net value described above.

Benefits include

- Becoming a Marie Skłodowska-Curie fellow and be invited to join the Marie Curie Alumni Association.
- Access to all the necessary facilities, technical platform and laboratories at ENSAM and SUT.
- Tuition fees exemption at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.

This project has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement Nº 101081465

- 10,000 EUR allowance to cover flights and living expenses for up to 12 months in Australia.
- 25 days paid holiday leave.
- Sick leave.

4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

Applicants must hold a Master's degree in a relevant discipline. The Master's degree must include a significant research component, leading to an Honours degree class 1 (average grade between 80-100) or class 2A (average grade between 70-79) level.

Applicants must also provide evidence of one of the following English language requirements:

- minimum IELTS overall band of 6.5 (Academic Module) with no individual band below 6.0 or a TOEFL iBT (internet-based) minimum score of 79 (with a reading band no less than 18 and writing band no less than 20); or Pearson (PTE) 58 (no communicative skills less than 50) no longer than 24 months before submitting the application; or
- satisfactory completion of Swinburne's English for Academic Purposes (EAP) Advanced level certificate at the postgraduate level (EAP 5: PG-70%); or
- successful completion of a total of 24 months (full time equivalent) of formal study where the language of instruction and assessment was English at AQF level 7 or above (or equivalent) at an approved university no longer than 60 months before submitting the application; or
- successful completion of a degree where the language of instruction and assessment was English at AQF level 8 or above (or equivalent) at an approved university no more than 60 months prior to submitting the application.

More information on ENSAM's requirements

Visit the website: https://artsetmetiers.fr/en/formation/doctoral-school

More information on Swinburne University of Technology's requirements

Visit the website: https://www.swinburne.edu.au/courses/applying/how-to-apply-research-degree/entry-requirements/#required-standards-of-achievement-research-experience

This project has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement № 101081465