

Training Opportunity for Luxembourgish Trainees

Reference	Title	Duty Station
LU-2022-TEC-MSPb)	Computational Materials and Processes Engineering	ESTEC

Overview of the mission

The Structures Mechanisms and Materials Division is the centre of competence of the Agency in all areas related to Spacecraft and Launcher Structures, and Mechanisms, Tribology and Pyrotechnic devices, as well as Materials and Processes. This encompasses spacecraft and launcher lightweight structures, stable structures, advanced mechanical materials applications, structural dynamics, damage tolerance, deployable structures/booms, active structures, hold-down and release devices, electrical motors for space mechanisms, launcher and re-entry vehicle hot- and cold structures, landing attenuation systems, seals, valves, parachute systems, separation systems, solar array drive mechanisms, reaction wheels, pointing mechanisms, pyrotechnics, bearings and tribology aspects. It provides support to projects, preparatory programs and technology programs.

The work proposed will be carried out in the Materials and Processes Section. The activities performed within the remit of the Materials and Processes Section include:

- The qualification for space flight of all advanced metallic and non-metallic materials, structural ceramics and glasses as well as all related manufacturing and surface treatment processes for all ESA spacecraft and launchers programmes
- The development of revolutionary materials and innovative manufacturing technologies both internally and in cooperation with other space agencies and research organisations
- The failure investigation of materials and processes underperforming and impacting ESA space missions
- The development, certification and support of new European industrial capabilities, manufacturing processes and manpower skills training related to space applications of materials and components
- The establishment and implementation of requirements and standards for the development and the procurement of space grade materials and manufacturing processes
- The development, maintenance and improvement of the European Space Materials Database, storing all relevant data generated for materials and processes intended for Space use

In order to achieve its objectives, the Materials and Processes Section is managing its test facilities in the world leading ESTEC Materials and Electrical Components Laboratory, covering the full spectrum of materials characterisation testing capabilities.

Candidates are encouraged to visit the ESA website: www.esa.int/ESA

Overview of the field of activity proposed

The European Space Agency has recently proposed the ESA Advanced Manufacturing Cross-Cutting Initiative, which captures the opportunity of adopting revolutionary manufacturing capabilities, advanced materials and associated processes and creates sustainable competitive advantage for the European Space Industry in the global market.

The current space missions are often limited in their performances and scientific achievements by the traditional manufacturing processes/concepts. Though Advanced Manufacturing technologies are readily available in the current European industrial landscape, these can be adopted for next generation space hardware manufacturing. This will enable new and highly innovative spacecraft and launchers designs, with significantly reduced manufacturing constraints (including costs and lead-time) and tremendous performances improvement.

Through this initiative, the Agency has identified a number of highly innovative materials and associated manufacturing processes which can be span-in and which will be matured to a space qualification level. In particular the following materials and processes are currently targeted:

1. Additive Manufacturing: Structure/property performance evaluation and model verification through mechanical and μ -mechanical characterisation
2. Friction Stir Welding, Solid State Joining Technologies for hybrid (metallic/Non-metallic) joining
3. Laser Shot Peening for structural integrity enhancement
4. Advanced composite materials (polymers, metal and ceramic matrix composites) and their performance characterisation and prediction in extreme environment
5. Advanced surface engineering for thermal and corrosion management
6. Solder joint reliability (mechanical and thermal fatigue) for high/low T electronics
7. Performance evaluation and Whisker growth behaviour of Pb-free solder alternatives
8. Integrated Computational Materials Engineering - model development and validation

You will use the world leading facilities of the ESA/ESTEC Materials and Electrical Components Laboratory, in order to characterise all the above advanced materials and manufacturing processes.

You will perform detailed developments for virtual testing and virtual failure investigations related to advanced manufacturing processes. In particular for:

- Static and dynamic (cryogenic and high temperature) micro-mechanical characterisation of materials for validation of process/structure/performance models for advanced manufactured parts,
- Development of P-S-P numerical models and codes, such as: Discrete Element, Finite Volume, Crystal Plasticity Finite Element, kinetic Monte Carlo, Phase Field and Molecular Dynamic,
- Development and implementation of data driven optimization and simulation techniques, such as: Physics-Informed Neural Networks and Generative Adversarial Networks,
- Implementation of software Validation and Verification techniques, through characterisation of simulated and experimentally derived mechanical performance in function of processing variables and target environmental loads.

Your work will be integrated in a team responsible for experimental data generation and guidance for project applications supporting future missions.

The final goal is to provide an in-depth understanding of the performances of the identified technologies and provide recommendations for further improvement in view of their space application in highly demanding environments.

Required background

- Master's degree in Material Science, Physics, Metallurgy, Material Informatics, Mechanics
- Technical knowledge in material science, computational science, material informatics, solid mechanics, metallurgy, programming, information systems
- Good interpersonal and communication skills
- Ability to work in a multi-cultural environment, both independently and as part of a team
- Fluency in English and/or French, the working languages of the Agency