

1 ERC PhD Position in
“Asymptotic Homogenization and Thermodynamics-based Artificial Neural Networks (TANNs)
for Complex Inelastic Materials and Generalized Continua”

AVAILABLE POSITION

The position provides the opportunity to work on a fundamental and computationally challenging research topic at the interface of continuum mechanics, applied mathematics, geomechanics, and scientific computing. The knowledge, methods, and software developed through this role will provide strong prospects for an academic or industrial career in computational mechanics, materials modeling, and multiscale simulation.

The research will be conducted at ENSTA, Institut Polytechnique de Paris (QS 24th worldwide in Mathematics, 4th in France, and QS 29th in Engineering & Technology, 1st in France, [see here](#)), in close scientific collaboration with BOKU University.

RESEARCH CONTEXT AND PROJECT SUMMARY

The research project aims at developing theoretical and computational methods for the **homogenization of nonlinear heterogeneous materials**, with applications to composites, geomaterials, fault zones, and architected materials. Particular emphasis will be placed on asymptotic homogenization beyond classical linear settings, including history-dependent and localization-dominated behavior, and on the emergence of generalized continuum descriptions, such as micromorphic media, directly from the underlying microstructure.

The analytical developments will be complemented by numerical homogenization and finite-element simulations. **Thermodynamics-based Artificial Neural Networks (TANNs)** will be investigated as reduced representations of the nonlinear constitutive and localization operators obtained from the microscale problems, with the aim of combining rigorous scale-transition methods with computationally efficient approximations while preserving energetic consistency and dissipativity.

DESCRIPTION OF THE POSITION

As a PhD researcher, you will focus on the computational realization, application and extension of new homogenization frameworks already established within the research team. The work will include implementation and verification of asymptotic and numerical homogenization methods for representative heterogeneous microstructures, development of reusable scientific software, and finite-element simulations linking microstructural response to macroscopic behavior. A central objective will be the numerical extension of the framework to nonlinear, history-dependent and localization-dominated material behavior, including the use of Thermodynamics-based Artificial Neural Networks (TANNs), automatic differentiation and data-driven reduced constitutive and localization operators. The developments will be assessed on applications involving composites, geomaterials and fault-zone materials relevant to the ERC-INJECT product as well as architected materials produced by additive manufacturing at IMSIA laboratory.

Principal supervisor: Prof. Ioannis Stefanou (ENSTA, Institut Polytechnique de Paris)

Co-supervisor: Dr Alexandros Stathas (BOKU University)

REQUIREMENTS

Successful candidates are expected to have strong scientific skills, intellectual curiosity, and high motivation. Fluency in spoken and written English is mandatory.

The researcher will carry out theoretical and computational research, develop reusable scientific software, and write scientific articles under the principal supervision of Ioannis Stefanou and the co-supervision of Alexandros Stathas, in close collaboration with the members of the INJECT group and international partners.

The candidate is expected to have:

- A Master's degree, or an equivalent qualification, in Mechanics, Applied Mathematics, Civil or Mechanical Engineering, Materials Science, Computational Science, or a closely related field.
- A strong background in numerical methods, scientific computing, continuum mechanics, finite-element analysis, or computational material modeling.
- Scientific computing experience is required; experience with scientific libraries and development of numerical research software is expected.

The following experience will be highly appreciated:

- Asymptotic, periodic, variational, computational, or FE^2 homogenization; multiscale modeling; micromorphic or other generalized continuum theories.
- Nonlinear constitutive modeling, plasticity, damage, localization, geomaterials, faults, composites, or architected materials.
- Machine learning for constitutive modeling, thermodynamics-based neural networks (TANNs), automatic differentiation, differentiable programming, PyTorch/JAX, reduced-order modeling, or high-performance computing.
- Ability to work independently and collaboratively in an interdisciplinary and international research environment.

CONDITIONS OF EMPLOYMENT

The appointment is planned for a duration of three years. The successful candidate will be appointed by ENSTA and will join the ERC-INJECT research group of Prof. Ioannis Stefanou. They will be based at the Mechanical Hub building, a collaborative environment housing leading research laboratories in mechanics from ENSTA and École Polytechnique, both members of Institut Polytechnique de Paris. The project will also involve regular scientific interaction and close collaboration with Dr Alexandros Stathas from BOKU University.

The research environment provides access to state-of-the-art computational resources (HPC), opportunities for collaboration and professional development, and regular interaction with researchers in mechanics, applied mathematics, and materials science.

The position includes opportunities to participate in seminars, doctoral training, international conferences, and research visits. Depending on interest and institutional arrangements, the candidate may also contribute to the supervision of student projects and teaching activities.

APPLICATIONS

The position is open and will start upon agreement.

Suitable, highly-motivated candidates should submit an application (including a CV, a research statement describing interests and qualifications related to the offered position and contact details or references of at least two reference Professors) to:

Prof. Ioannis Stefanou: ioannis.stefanou@ensta.fr

Dr Alexandros Stathas: alexandros.stathas@boku.ac.at

Candidate selection will be based on scientific excellence, motivation, fit with the research topic, and the potential to contribute to a collaborative research environment.