



## Call for application for a postdoctoral fellow

### Study of hydrogen embrittlement risk in high-strength steel fasteners under stress in hydrogenating environments

SMS RESEARCH CENTER/MPI DEPARTMENT

#### JOB ENVIRONMENT:

*Institut Mines-Télécom* is the leading public group of engineering and management *Grandes Écoles* in France. Consisting of eight public graduate *Grandes Écoles* and two subsidiary graduate schools, *Institut Mines-Télécom* leads and develops a rich ecosystem of partner schools, economic, academic and institutional partners, key players in education, research and economic development.

Mines Saint-Étienne, a graduate school of the *Institut Mines-Télécom*, is responsible for education, research, innovation, industrial transfer and scientific culture dissemination. With 2,500 students, 500 staff and a budget of €50m, it has 3 campuses dedicated to the industry of the future, health and well-being, and digital sovereignty and microelectronics. It is ranked in the top 15 graduate engineering schools in France and the top 500 universities worldwide.

The 2023-2027 strategy of Mines Saint-Etienne is in line with that of *Institut Mines Telecom*. It aims to:

- Support the ecological, digital and generational transitions and educate the people involved
- Support national and European sovereignty in microelectronics and digital technolog

To support this strategy, it is recruiting a postdoctoral fellow.

#### JOB DESCRIPTION:

The position is based on the Saint-Étienne campus, in SMS Center. It is a materials and mechanical engineering research center with strong focus on physical metallurgy and in particular environmentally assisted cracking of industrial components in energy and transportation industry. It has developed expertise in coupled experimental and modeling approach of stress corrosion cracking and hydrogen embrittlement based on slow strain-rate and corrosion-fatigue tests aimed to reproduce 'in service' damage and subsequent crack path analysis (SEM, STEM and EBSD on FIB foils).

The job is interested in the study of hydrogen embrittlement risk in high-strength steel fasteners under stress in hydrogenated environments. High-strength steel fasteners for mechanical applications are crucial in numerous industrial sectors, especially in the automotive industry. They must ensure the integrity of systems subjected to various mechanical and environmental stresses throughout their lifespan, as the failure of a fastener can have catastrophic consequences. One cause of fastener failure is Hydrogen Embrittlement (HE), with hydrogen sources being either internal (during manufacturing) and/or external (environmental exposure). In high-strength steels, beyond a certain hardness range, the applied load on the fastener can lead to hydrogen diffusion into the stressed area, progressively initiating and propagating cracks. Preventing failures and managing the risk of HE are fundamental considerations that engage many stakeholders in this industrial sector. The proposed study fits within this framework and will be conducted in collaboration with CETIM (Technical Center for Mechanical Industries).

HE has been studied for many years. Several mechanisms have been proposed, involving a reduction in cohesion energy, facilitated dislocation emission, or slip localization. Additionally, the presence of crystalline defects affects hydrogen diffusion and can promote the segregation of this solute at preferential sites following its adsorption and absorption. These models have shown that HE damage are related to the diffusion and

segregation processes of hydrogen. The diffusion and trapping phenomena of the solute are strongly influenced by the material's microstructure, composition, and local stress state.

The work to be carried out in this postdoctoral position will build on this scientific literature and focus on studying the HE of martensitic and bainitic steel grades with different hardness levels. The HE sensitivity of these steels will be characterized mainly through slow tensile tests directly on fasteners under cathodic polarization. Various test parameters will be studied (strain rate, current density, etc.). Analytical methods at different scales will be used to characterize damage and identify the mechanisms involved (SEM-FEG, EDX, EBSD, XRD, STEM on FIB lamella, TDS).

#### **PROFIL SOUGHT:**

We are looking for a recent Ph.D. graduate in materials science and physical metallurgy, ideally with experience in hydrogen embrittlement phenomena. The candidate should have a strong inclination for teamwork, experimentation, and be familiar with several characterization and analysis techniques outlined in the program.

#### **WHY JOIN US:**

*Institut Mines-Telecom* is characterised by:

<https://www.youtube.com/watch?v=m39m6hdNC48>

- A scientific environment of excellence
- A group with entities throughout France

Mines Saint-Etienne is distinguished by:

- A privileged working environment with a high student supervision rate and a high environment rate (support and back-up functions)
- First-rate experimental and digital resources
- Significant contract research activity (€11m/year in Research and Innovation contracts), mainly with industrial partners
- 25% international students, Member of the T.I.M.E. network and the EULIST European University
- A centre for scientific, technical and industrial culture - *La Rotonde* - which is unique in France, and which has a major impact on society (> 50,000 visitors per year)
- Pleasant workplace, easily accessible by public transport and close to motorways
- Public transport costs reimbursed up to 75% (subject to conditions)
- Sustainable mobility package
- Staff committee that subsidises sports, leisure, cultural and social events and activities
- The possibility of partial remote working
- 49 days annual leave

#### **ADDITIONAL INFORMATION:**

##### **Recruitment conditions:**

- Fixed-term contract for a period of 12 months
- Desired start date: **01/12/2024**
- Remuneration will be set according to the candidate's profile, based on the rules defined by the *Institut Mines Télécom's* management framework
- Full time
- Position based in Saint-Étienne

The position is open to all, with accommodation available on request for candidates with disabilities.

The job is open to civil servants and/or the general public.

All applications may be subject to an administrative enquiry.

### How to apply:

Applications (CV, covering letter, letter of recommendation if applicable) must be submitted on the RECRUITEE platform **no later than 04/08/2024** :

<https://institutminestelem.com/recrutee.com/o/post-doctorant-ou-post-doctorante-en-etude-du-risque-de-fragilisation-par-lhydrogene-delements-de-fixation-en-acier-a-haute-resistance-mecanique-mis-sous-contrainte-en-milieu-hydrogenant-cdd-12-mois-2>

**Candidates selected based on their application will be contacted by email for a first videoconference interview.**

As part of its Equality, Diversity and Inclusion policy, École des Mines de Saint Etienne is an employer that is committed to fair treatment of all applicants.

### For further information:

For further information about the position, please contact:

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For all administrative information, please contact:

Julie JAFFRE – HR Administrator

Email: [julie.jaffre@emse.fr](mailto:julie.jaffre@emse.fr)

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### Useful links:

<https://www.mines-stetienne.fr/>

<https://www.imt.fr/>

<https://www.youtube.com/watch?v=QUeuC5iQiN0>

Protecting your data:

<https://www.mines-stetienne.fr/wp-content/uploads/2018/12/Informations-des-candidats-sur-les-traitements-de-donn%C3%A9es-personnelles.pdf>