

PhD position starting in the autumn of 2025

Center for Materials Forming (CEMEF), MINES Paris - PSL University
Soft Matter Sciences and Engineering Laboratory (SIMM), ESPCI - PSL University

Magnetic granular aerogels for soft robotics

Magnetic soft materials are capable of tether-free, instantaneous and “programmable” shape change in a magnetic field, which is promising for various biomedical and industrial applications, including minimally invasive medical procedures and targeted delivery [1]. Precise magnetic actuation requires the use of bottom-up fabrication techniques in which magnetic interactions are well-controlled on the level of the structural element. The objective of this PhD project is the fabrication of magnetic, bio-based, porous particles with tailored magnetic and mechanical properties. Magnetic iron oxide nanoparticles will be embedded within bio-based aerogel beads (nanostructured, stable and porous materials) and different methods for the assembly of these beads into macroscopic structures will be investigated. Also the rheological properties and behaviour in magnetic field of the granular materials will be explored towards their use in soft robotics.

This explorative and interdisciplinary project is located at the interface of material chemistry and soft matter. The majority of the work will be performed at CEMEF - MINES Paris in Sophia Antipolis in the south of France. This lab has extensive experience in the preparation and physico-chemical characterization of bio-based aerogels [2]. The rheological characterization and magnetic behavior of the bio-aerogel bead assemblies will be investigated at the SIMM - ESPCI lab in Paris. The PhD candidate will take benefit of the scientific environment and expertise of both MINES Paris and ESPCI, and will be the key actor in this fully funded collaborative project. The PhD candidate will be encouraged to participate in dissemination of results at national and international conferences and in the form of scientific publications.

Keywords: Bio-based polymers, porous materials, physico-chemical properties, functional materials

Profile: Knowledge of materials science, ideally with experience in soft matter and rheology or mechanics; fluent in English; taste for initiative; MSc thesis (or equivalent) completed

Duration: 3 years, starting in autumn 2025

Locations: CEMEF (part of MINES Paris but located in Sophia Antipolis in the south of France) and SIMM (part of ESPCI Paris, France)

Funding: PSL University (METASOFT program)

PhD supervisor: Dr. Sijtze Buwalda (MINES Paris)

Co-supervisors: Dr. Artem Kovalenko (ESPCI) and Dr. Loren Jørgensen (ESPCI)

Please send your detailed CV, motivation letter, marks of your Bachelor and Master courses and at least two e-mail addresses of reference persons to sijtze.buwalda@minesparis.psl.eu.

References:

1. Kim, Y.; Zhao, X. Magnetic Soft Materials and Robots. *Chemical Reviews* **2022**, *122*, 53175364. <https://doi.org/10.1021/acs.chemrev.1c00481>.
2. Budtova, T.; Aguilera, D. A.; Beluns, S.; Berglund, L.; Chartier, C.; Espinosa, E.; Gaidukovs, S.; Klimek-Kopyra, A.; Kmita, A.; Lachowicz, D.; Liebner, F.; Platnieks, O.; Rodríguez, A.; Tinoco Navarro, L. K.; Zou, F.; Buwalda, S. J. Biorefinery Approach for Aerogels. *Polymers* **2020**, *12*, 2779. <https://doi.org/10.3390/polym12122779>