PHD OPENING

Doctoral School Fundamental and Applied Sciences

Expected profile

- Engineering degree or MSc in physico-chemistry of materials, rheology, fluids thermomechanics
- Excellent writing skills, fluent in English
- Rigorous, autonomous, creative and motivated by working within a multi-disciplinary team
- Skills in modeling of physical phenomena using experimental tests and numerical computations, and strong affinity for experimental work.
- Knowledge in polymeric materials, forming processes, image analysis and programming in Python appreciated.

Working conditions

The PhD student will be supervised by:

- **Edith Peuvrel-Disdier** (CNRS research scientist), specialist in the flow of complex fluids
- **Patrice Laure** (CNRS research director), specialist in computational fluid dynamics

The proposed work will be conducted in the research group *Computing & Fluids* at the CEMEF, research center of MINES ParisTech, located in Sophia-Antipolis (France) in strong collaboration with the research center of Hutchinson in Montargis (France). The selected candidate will be employed by Hutchinson, a company of TOTAL, in the framework of an industrial convention for research training (CIFRE convention with ANRT) during the three-year doctoral contract that should start by the end of 2019. Regular stays will be organized at Hutchinson.

Contact and application procedure

For further information, please contact
E. Peuvrel-Disdier (edith.disdier@mines-paristech.fr)
P. Laure (patrice.laure@mines-paristech.fr).

Morphological analysis and modeling of the foaming process of elastomers

The main objective concerns the optimization and prediction of cellular structures in elastomeric materials for vehicle sealing parts. This allows producing lighter parts (CO_2 reduction) with a good acoustic and mechanical behavior.

The rubber formulation contains a chemical foaming agent. When the mixture is injected, the heat supplied by the mold activates the gas production reaction, but also the vulcanization. The challenge is to control the process so that the mold is filled and the gas released before vulcanization. The objective is to understand the main mechanisms governing the foaming process in order to better control the cells size and the dimensions of the part after opening of the mold.
The relationship between the microstructure and the various parameters of the process has to be established. Experiments will be performed on an instrumented mold. X-ray micro-tomography and image analysis will be used to characterize the microstructure of the foams. Dedicated experiments will be designed in order to better understand the different physico-chemical phenomena.

The modeling of the cellularization at the micro and macro scale will enable to understand on one hand the evolution of a bubble in an elastomer under pressure and temperature and on the other hand to have the distribution of bubbles sizes in a molded part at the end of the process. Calculations will be done in Python at the micro scale and using the REM3D® software (TRANSVALOR) at the macroscopic scale. The theoretical developments will be compared to the experimental observations. The modeling results will be integrated into the REM3D® software.

Example of image analysis process

This PhD work is part of the research work conducted within the industrial chair Design Engineering of Elastomers and Polymers (DEEP) between Hutchinson, MINES ParisTech and ESPCI. The PhD student will benefit much from this environment and will diversify his/her expertise through strong scientific interactions with team and industrial chair members.

This project is strongly transdisciplinary (physics, data analysis, modelling, computing applied to engineering).