Dimensional stability of PP / EPDM blends under thermomechanical loading; Microstructure effect and processing

Main objective :
The aim of the project is to progress in the understanding of the mechanisms involved during long-time deformations of co-continuous PP / EPDM polymer blend, mechanisms being related either to stress relaxations or to creep effects during loading combining thermal cycling and mechanical solicitations (traction, compression).

Context and challenges :
In many industrial applications, and more especially in the automotive industry, expectations are high in terms of providing materials with specific physical and mechanical properties. Innovative materials based on polymer blends are ideally suited to meet such challenges.

Some co-continuous PP / EPDM polymer blends, subjected to compression loading over a long period of time, are exhibiting creep mechanisms deteriorating the functionality of parts such as vehicle body seals.

In order to answer such issues, Hutchinson group (part of Total company) is launching a fundamental study of the physical processes and microstructural evolution related to both the process conditions and the thermomechanical loading.

This project is part of the industrial engineering DEEP chair (Design Engineering of Elastomers and Polymers) coordinated by Hutchinson, and bringing together two academic partners: MINES ParisTech and ESPCI.

Detailed presentation:
The project will be organised into four parts and will combine microstructural analysis, experimental mechanics and numerical micromechanical modelling:

Part 1: Characterization of the initial microstructure and its evolution upon loading
An important step will be to characterize the different microstructure of the samples obtained for different processing conditions. For this, the student will be able to rely on the expertise of the Thermoplastics and Innovation Laboratory of the Hutchinson Research and Innovation Center. In order to characterize the microstructure, all available devices will be used: optical and electronic microscopy (SEM), X-ray microtomography, AFM, X-ray diffraction at wide and small angles.

Part 2: Mechanical characterization, analysis and relation with the microstructure
On the basis of the conditions identified in Part 1, an exhaustive mechanical characterization of the different phases as well as the blend will be carried out and linked to the microstructure. The student will be able to rely on in-situ mechanical tests coupled with observations made using synchrotron facilities.

Part 3: Micromechanical approach
The knowledge of the phases behaviour and their organisation will be used for micromechanical modelling based on existing digital facilities at CEMEF (a Mines ParisTech Research Laboratory). The purpose will be to perform "virtual rheology" type of analysis.

Part 4: Synthesis and modelling path
The results will be synthesized and compared, to define what could be the physical laws associated with the different observed mechanism.

Keywords	Thermoplastic elastomers, PP/EPDM, microstructural

	characterisation, mechanical characterisation
Expertises	Engineer or Master in Material and Mechanical Engineering. Knowledge in Polymer Science.
Project	DEEP Industrial Chair, coordinated by Hutchinson (Total Group)
Rémuneration	27 k€ per year
Working place	MINES ParisTech – CEMEF, Sophia-Antipolis (06), France
Team in CEMEF	Mechanics and Physics of Industrial Polymers (MPI)
Supervision	- CEMEF : Prof. Noëlle Billon noelle.billon@mines-paristech.fr