Call for applications for a Ph-D thesis in the laboratories MATEIS and IMP at INSA-Lyon, France

Topic: Understanding the consequences of processing defects on the ultimate and fatigue properties of elastomers.

Elastomers are materials with a complex formulation; they contain numerous ingredients necessary for their crosslinking and their processing, and usually a significant amount of rigid particles, initially nanoscopic, used to improve their mechanical and chemical properties. The mixing step of the polymer with all these ingredients is crucial, as it leads to the formation of a reinforcing multi-scale structure and, depending on its efficiency, to the presence of more or less numerous defects, more or less isolated, with a size above the micron.

The consequences of these defects on the mechanical properties are still poorly documented, for several reasons. The first one is that the nature of these defects is difficult to characterize methodically. They are most of the times agglomerates, zones with an over-concentration of fillers which can be dry (fragments of the initial granules) or impregnated by elastomers or oils and badly re-dispersed ; they can also be unfilled elastomer zones, and even air micro-bubbles. But the main reason is that so far, we still do not have a methodology providing in an accurate and reproducible manner a pertinent description of the density and of the spatial distribution of these defects: this is due to the relative youth of the techniques (X-Ray tomography) enabling a 3D microstructural characterization of the materials. Hence, there are no studies in literature establishing a direct relationship between these agglomerates and defects and the fatigue and rupture properties of elastomers (even though the consequences of the defects on the latter are often suggested).

The topic of this Ph-D thesis is therefore to establish relations between the density, the size and spatial distribution of micron size agglomerates or other defects and the ultimate and fatigue properties of a Carbon Black filled EPDM elastomers. This will be performed thanks to the development of a precise methodology for characterization of their microstructure by X-Ray tomography. The studied elastomers will be formulated and processed in order to obtain controlled and differentiated microstructures. To clarify the complete sequence : process → structure of defects → properties, the thesis will be performed in the frame of a partnership between the MATEIS laboratory (microstructural and mechanical characterization), the IMP laboratory (material processing, rheology), and the LRCCP laboratory (processing, fatigue properties).

Mai location: Campus de la Doua, Lyon, 20 minutes from Lyon city center.
Collaboration : *Laboratoire Matériaux : Ingéniérie Sciences* (MATEIS, équipe PVMH http://mateis.insa-lyon.fr/fr/content/pvmh), *Ingénierie des Matériaux Polymères* (IMP, http://www.imp.cnrs.fr/spip.php?rubrique41), *Laboratoire de recherches et de contrôle du caoutchouc et des plastiques* (LRCCP, *www.lrccp.com*).
Duration: 3 years.
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Grant type: Thèse CIFRE (around 2500 € brut/month)
Key words: Elastomer, X ray tomography, mechanical properties, rupture, fatigue
Required skills: the candidate should hold a Master degree in materials science and or materials mechanics. Skills in the polymer field will be highly appreciated : polymer physics, and/or polymer rheology and processing, and/or polymer mechanics.
The candidate should send a complete CV, a motivation letter, his/her evaluation marks during Master, and possibly a recommendation letter or persons to contact.