

## ► Laurent FERRY

Fonction : Professeur.....

Pôle de rattachement : MPA.....

Téléphone : 04-66-78-53-58.....

Adresse de messagerie : laurent.ferry@mines-ales.fr.....



### Research Topics

#### Topic 1: Fire behavior of polymers

The aim of this topic is to improve the reaction-to-fire of polymeric materials through the development of new multi-component and environmentally friendly flame retardants. The most recent works on this subject are focused on (i) the use of micro and nanofillers leading to complex barrier effect, (ii) the study of flame retardant solutions for biocomposites, (iii) the development of green flame retardants from phenolic bioresources. Efforts are also made to characterize combustion effluents (gas or particles) and understand their resuspension in relation with polymer decomposition pathway. Finally we are involved in the development of multi-scale fire experiments and their modeling in order to establish relation between small scale, bench scale and large scale tests.

#### Topic 2 : Ageing of composites

This topic leads us to develop original methods for the characterization of composites ageing based on a pluridisciplinary and multiscale approach. Ageing phenomena are investigated at molecular scale (e.g. chain scission), at macroscopic scale (follow-up of mechanical properties) but also at mesoscopic scale using photomechanics for example.

### Recent Publications

- R. Sonnier, G. Dorez, H. Vahabi, C. Longuet, L. Ferry, J.M. Lopez-Cuesta, FTIR-PCFC coupling: A new method to study the combustion of polymers, *Combustion and Flame*, 161, 1398-1407, 2014
- G.Dorez, A. Taguet, L. Ferry, J.M. Lopez-Cuesta, Phosphorous compounds as flame retardants for Polybutylene Succinate/Flax biocomposite: additive versus reactive route, *Polymer Degradation and Stability*, 102, 152-159, 2014
- G.Dorez, B. Otazaghine, A. Taguet, L. Ferry, J.M. Lopez-Cuesta, Improvement of the fire behavior of PBS/flax biocomposites by fiber surface modification with phosphorous compounds: molecular versus macromolecular strategy, *Polymer International*, 63, 1665-1673, 2014
- G.Dorez, L. Ferry, R. Sonnier, A. Taguet, J.M. Lopez-Cuesta, Effect of cellulose, hemicellulose and lignin on pyrolysis and combustion of natural fibers, *Journal of Analytical and Applied Pyrolysis*, 107, 323-331, 2014
- R. Ménard, G. David, C. Negrell-Guirao, L. Ferry, R. Sonnier, Synthesis of new flame-retardants by radical chain transfer copolymerization of Glycidyl Methacrylate and Dimethoxy-phosphorylmethylmethacrylate. Evaluation of flame retardancy in epoxy matrix, *European Polymer Journal*, 57, 109-120, 2014
- R. Ménard, C. Negrell-Guirao, L. Ferry, R. Sonnier, G. David, Synthesis of biobased phosphate flame retardants: characterization of flame retardancy in epoxy thermosets, *Pure and Applied Chemistry*, 86 (11), 1637-1650, 2014

- H. Vahabi, R.Sonnier, L. Ferry, Effects of ageing on the fire behavior of flame retarded polymers: A review, Polymer International, DOI 10.1002/pi.4841

**Research works in progress**

- Development of new flame retardants from bio-resources
- Coupled effect of ageing on mechanical and fire properties of epoxy/natural fibers composites
- Multi-scale approach of polymer burning
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