Polytech network form for PhD Research Grants from the China Scholarship Council

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PhD information	
Title	**Fatigue Behavior of Elastomers used in the aeronautical applications : Innovative approaches using thermal and mechanical signals treatment**
Main topics regards to CSC	IV-1 : Nanotechnology and Nanotechnique

list (3 topics at maximum)	IV-6 : Calculation of materials and simulation for design IV-10 : Biomaterials and polymer materials
Required skills in science and engineering	Mechanical Theoritical background

Subject description (two pages maximum)

Rubbers are widely used in the industry thanks to their ability to undergo large strain and to damper energy. Consequently, they don't evacuate heat easily, meaning that the temperature of an in service part can reach significant values. This need to be anticipated as the behavior of those materials is very temperature and time dependent.
One consequence is that rubbers can exhibit self-heating under a mechanical loading without undergoing noticeable damage [Wattrisse et al. 2011] which is mainly caused by the viscoelasticity property of those materials [Meinecke 1991]. The latter depends on the strain rate [Lion 1997], the maximum loading [Cruanes et al. 2013] and the shape of the sample [Ayoub et al. 2012]. Moreover, under suitable conditions and depending of the type of rubber, the strain induced crystallization ca be detected by a change in the evolution of the self-heating. However, the influence of the SiC is better observed when working on the thermal sources [Samaca Martinez et al. 2013].
The thermo-mechanical behavior of rubbers during fatigue tests was also investigated. In some cases, the modeling of the evolution of the self-heating was the target: [Boukamel et al. 2001] have proposed a solution of the thermo-mechanical problem using a variational formulation applied to the rheological model of Poynting–Thomson. The later implementation into a FE code achieved its numerical solution [Meo et al. 2002]. Another approach from [Ovalle Rodas et al. 2014] was to develop a large strain thermoviscoelastic constitutive model to describe the self-heating of rubber material low fatigue life tests.
A another way consist in a 0 D approach considered as a way to anticipate the fatigue life when coupled with another technique [Marco et al. 2017]. The thermal measurement would also allow for a rapid determination of the change of the low cycle and high cycle fatigue behaviors [Cruanes et al. 2014], method generalized on rubbers from many studies on other materials (metals) [Doudard et al. 2005] or short fiber reinforced polymer [Jegou et al. 2013] for example).

Based on the previous work of the LaMé team, the aim of the phD thesis is to consolidate this thermal approach for fatigue by coupling it with others technics such as signal processing [Hirschberg, 2017] or instrumented indentation [Fradet, 2017].
These approaches will be correlate with microstructure by different observations like SEM or XRay Tomograph.
The thesis will be manage in the Gabriel LaMé laboratory by means of the research center dedicated on Polymers et Elastomers materials.

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[Cruanes et al. 2013] C Cruanes, G Berton, F Lacroix, JL Poisson, S Méo, N Ranganathan, Study of fatigue behavior of rubber like materials with infrared thermography methods, Constitutive Models for Rubber VIII, 2013

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