EVOLUTION OF STRESS/STRAIN STATE AND CONTACT AREA OF WORN ELASTOMERS DURING SHEARING

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ABSTRACT
Under increasing shear, the contact between a rough elastomer and a rigid surface, for example in the case of contact between a tire and a road surface, may undergo significant changes in terms of morphology of the micro-contacts due to the presence of wear, even under a constant normal load [1]. In such contacts, it is also possible to observed strong variation of the local pressure during shearing that may be related to the wear patterns that are frequently observed in literature [2]. Such morphological and loading changes are indeed expected to affect all macroscopic responses of the interface.

In this study, our aim is to analyze the contact stress/strain state during shearing of a sphere made of model elastomers representative for tire tread materials (e.g. Natural Rubber based) prepared by using different types of silica. These analyses are performed on either pristine or previously worn samples at different stages of the wear evolution by measuring not only the classical evolution of macroscopic normal and tangential forces but also that of the true contact area and interfacial stress/strain fields. To do so, both experimental and numerical approaches have been used.

The experimental tests consist in shearing experiment performed on a new generation opto-mechanical device recently developed in our laboratory [3]. It enables rich contact loading through five simultaneous and independent degrees of freedom) with simultaneous high-resolution monitoring of all three forces and three moments at the contact interface. It also enables high-resolution in-situ visualization of the contact area, giving access to in-operando, measurements in the real contact area of the stress/strain fields through advanced image analysis techniques [4]. Prior to use complex worn rubber elastomers, we performed preliminary tests on truncated spheres of standard elastomer in order to reproduce in a simple and controlled manner the wear evolution.

In parallel, the development of an improved, comprehensive numerical model of contact between an elastomer and a rigid surface has been made. It incorporates the local contact conditions (morphology and mechanical properties). This model has been used first on model truncated sphere similar as those used in the experiments. It allows to extract the local stress/strain state, at different scales and to better understand the global effect of the morphology evolution. Ultimately, it should help in understanding the link between local contact conditions and wear mechanisms.

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