Debonding mechanisms of non-vulcanised elastomers

Nassim Pujol, SIMM laboratory

Tire manufacturers are constantly looking for a reduction of the rolling resistance of their products on the one hand, and for an increase of their adherence on the other hand. To reconcile those two characteristics, tire companies tend to modify the composition of their rubber. The two major changes operated recently are the addition of resin to polymer mixtures and the use of silica particles as a replacement for carbon black. The performance of the end product is well predicted. Nevertheless, the mechanical properties of the uncured and filled rubber are responsible for major industrialisation problems. In particular, during the shaping of the tread in the cylinder lamination tool, the viscous and non-linear material is subjected to two phenomena: either it becomes cracked as a brittle material, or it sticks excessively to the metallic cylinders. A collaboration between Michelin and the SIMM laboratory was created to study the dissipative mechanisms at the origin of the strong adhesion and the weak cohesion of this little known material composed of uncrosslinked elastomers, resin, and silica. Facture mechanics of soft materials [1] gives us tools to understand some dissipative mechanisms which play a role in the debonding of rubber. However, it is difficult to transpose debonding modes from one device to another with the shift of geometries of the test. In this study, we hope to improve the comprehension of the phenomena occurring between the metallic cylinders by reproducing the dissipative mechanisms at their origin on an instrumented test well understood: the peeling test. With cameras, several debonding behaviours were identified at different strain rates. A cohesive rupture occurs at low strain rate while the debonding front propagates at constant speed at high strain rate. At an intermediate strain rate, these two phenomena are separated by a Stick/Slip behaviour, with similar characteristics to observations made on PSAs [2]. This project aims at linking the rheological properties of typical rubber materials with their adhesive properties to result in a model to predict the conditions necessary to the initiation of the crack propagation at the interface between the polymer material and the metallic cylinder.

[1] C.Creton, M.Ciccotti, *Reports on Progress in Physics,* 2016, **79**(4).
[2] D.W.Aubrey, G.N.Welding, T.Wong, *Journal of Applied Polymer Science,* 1969, **13.**