

Active chain density effect on the fatigue resistance of Natural Rubber

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Abstract.

Natural rubbers (NR) are used in many industrial applications due to their unique fatigue properties, especially under non-relaxing loadings for which a strong reinforcement of their lifetime is observed [1]. The fatigue resistance of NR depends on many factors. Among them, the chain network appears as a dominating one [2-4]. For instance, polysulphide crosslinks were shown to enhance the fatigue properties [2] whereas mono-and-disulphide crosslinks promote the resistance to thermal degradation [5]. The crosslinking length as well as the distance between the crosslinks (the active chain density) are triggered by the vulcanization conditions. Thus, both parameters depend on the ratio between sulphur and accelerator amounts as well as the process conditions such as time, temperature, and pressure. Although literature is abundant on that matter, the relationship between the active chain density and the fatigue properties has not been fully understood yet. Addressing the issue appears even more relevant since the active chain density influences the Strain-Induced Crystallization (SIC) phenomenon [6-8] that is generally assumed to be responsible for the lifetime reinforcement under non-relaxing loadings.

The present study deals with the effect of the active chain density on NR fatigue properties, through various chemical compositions, vulcanization systems and process conditions. A physico-chemical characterization of each formulation by swelling experiments has been carried out in order to estimate the active chain density with the Flory-Rehner relation [9,10]. Fatigue tests have been carried out under different loading ratios, corresponding to relaxing and non-relaxing tension loadings. Results obtained enable us quantifying the effect of the chain network density on the fatigue properties.

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