Quantifying the Enhancement Effect of Strain Induced Crystallization on Tearing Energy by Edge Crack Test Method

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ABSTRACT

Fracture toughness in elastomer can be described utilizing fracture mechanics based on the tearing energy concept. Tearing energy, *G*, is significantly influenced by the visco-elastic properties arising from mechanical hysteresis, resulting *G* increases with increasing strain rate and/or decreasing ambient temperature as viscoelastic energy dissipation increases.

However, this influence of viscoelastic energy dissipation becomes less marked for strain induced crystallizing elastomer, like natural rubber (NR). If the sufficient strain induced crystallization (SIC) can be generated ahead of advancing crack tip, catastrophic crack growth process is postponed and fracture process is governed by SIC originated strength, G_{SIC}, which is considerably higher than viscoelastic energy dissipation effect. Hence SIC elastomer can be regarded as self-assemble elastomer. However, this self-assemble capability has threshold condition as crystal has melting temperature and SIC is kinetic phenomena. In another word, fracture toughness in SIC elastomer shows transition between governed by SIC and merely by viscoelastic energy dissipation at certain temperature and strain rate. It is clearly important to fully understand this threshold condition for engineering appreciation but was not fully investigated and elucidated.

It has been shown that the failure of elastomer is initiated from flaws or stress raisers present in elastomer. For a strain-crystallizing elastomer, an abrupt drop in fracture toughness as a function of initial flaw size is observed. The mechanism of this abrupt fall is thought to be the change in fracture process from a cyclic crack growth process to catastrophic tearing. We focused on this failure mechanism transition to determine the threshold condition for generating G_{SIC} and extended conventional theoretical studies.

In this presentation, newly extended theoretical understanding for fracture toughness transition as a function of initial crack length, quantitative determination of G_{SIC} and its threshold condition linking to nano-micro-macro polymer structure will be reported.