

Natural rubber to filler interaction study by determining creep rupture strength

By

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This thesis was submitted to the department of Materials Engineering of the University of Moratuwa in partial fulfillment of the Degree of Master of Science in Polymer Engineering.

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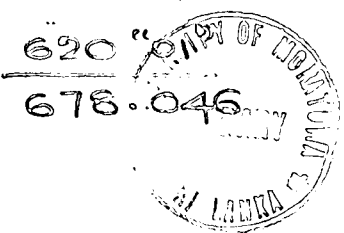
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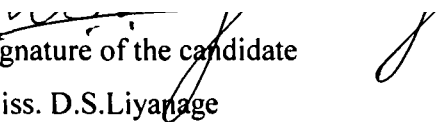
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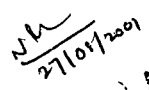
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Abstract

Creep rupture of clay-rubber composites was studied by 180° peel test of flexible to rigid joints to evaluate the rubber-filler interaction. Static load providing separation of specimen at equilibrium peel rate, corresponding to 10^{-8} m/sec, the rate at which a kinetic segment of a hydrocarbon chain moves in an elementary event of thermal motion, was treated as peel strength of a specimen at creep rupture.

A methodology was developed to measure the peel strength at creep rupture in an open air and liquid medium active towards the interface of joined materials. Series of monohydric alcohols was selected since lower alcohols are strongly hydrogen bonded solvents whilst higher alcohols tend to strong dispersion interaction. The change in peel strength values due to variation of solubility parameter of the selected alcohols was used for identification of molecular bonds established across rubber filler interface.

Decreasing in the peel strength values with increasing in despersive component of the solubility parameter of the hostile medium indicated the presence of dispersion bonds across rubber-filler interface. Hydrogen and polar bonds were identified by decreasing the peel strength values due to increasing polar component of the solubility parameter of the alcohols to which a specimen was exposed, while stability of joints to action of hostile medium, proved the presence of chemical bonds established across the rubber - filler interface.

Obtained peel-strength values correlated well with bound rubber content, ensuring that the results have realistically characterized rubber-filler interaction. The chemical nature of the filler surface was the main factor influencing it, that has made possible in commercial practicability the modification of the inert filler in order to enhance its effect on rubber properties.

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Nomenclature

- A - Physical creep rates
- B - Chemical creep rates
- χ_0 - initial deflection
- χ_1 - deflection at time t
- C - volume fraction of the solid spheres
- δ_a - associative component of solubility parameter
- δ_d - dispersive component of solubility parameter
- δ_e - mean cohesion or aggregation energy per particle between the particles in the original aggregate
- D - uniform diameter
- d - ultimate particle diameter
- E - Young's modulus of the rubber
- F - total energy of immersion per unit surface area of the filler in rubber
- FF - fine furnace
- HAF - high abrasion furnace
- MT - medium thermal
- M - moduli of elasticity of the filled polymer
- Mo - moduli of elasticity of the unfilled polymer
- N - number of filler particles
- n - number of measurements
- PVA - Poly Vinyl Alcohol
- ρ_f - functional heat term
- ρ - density
- RSS - Ribbed Smoked Sheet
- SAF - super abrasion furnace black
- SRF - semi-reinforcing furnace
- t_0 - initial time
- t - time
- V - volume



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