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THERMAL AGEING AND γ-RADIATION RESISTANCE OF POLYISOPRENE /CHLOROSULPHONATED POLYETHYLENE RUBBER BLENDS

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Abstract

The effect of carbon black (average particle size 26nm) and wood flour (particle size from 300 to 400 μm) on thermal ageing and γ-radiation resistance of polyisoprene /chlorosulphonated polyethylene rubber blend (NR/CSM) was studied. The tensile strength of the aged samples was determined, after conditioning at 70°C during 72h. The radiation exposure of samples was performed at two doses: 212 and 400 kGy.

Introduction

Rubber compound are composed of fillers, curing agents, and other chemical additives to improve processing behavior and ageing properties of final crosslinked material [1]. Degradation of rubber is accelerated mainly by heat, humidity, light, radiation etc. The aim of these work was to study the influence of carbon black and wood flour on curing characteristics and thermal aging and high-energy radiation resistance of polyisoprene/chlorosulphonated polyethylene rubber blend (NR/CSM).

Experimental

Natural rubber, type SMR CV 60 was supplied by Malaysia; Chlorosulfonated polyethylene rubber type, Hypalon 40S, was supplied by Du Pont, USA; Carbon black (CB) HAF-HS (DBP 120ml/100g (average particle size 26nm); Wood flour (WF) was obtained from M/s Kosla Metal Powder Co. Pvt. Ltd, Pune, India, (particle size from 300 to 400 μm). Phenolformaldehyde resin (PF), type VULKADUR A was used to achieve better adhesion between rubber macromolecules and wood particles. Other ingredients such as zinc oxide, stearic acid and sulfur. Mixing was carried out on a two-roll mill at 40°C and 1:1.25 speed ratios according to ASTM D 3182. For thermal ageing study the specimens for tensile measurements were kept in an air oven, maintained at 70 °C for 72 h. Irradiations have been performed in air in the Co-60 radiation sterilization unit with the dose rate of 212 and 400 $kGyh^{-1}$.

Result and Discussion

In the table I are summarized data obtained by Monsanto rheometer (scorch time t_{s2}, cure time t_{c90}, cure rate index (CRI) and MU(1+4) at 373K for componds with different ratio of filler. It is obvious that compounds with carbon black CB have higher Ml, Mh, CRI and MU (1+4) at 373K values than those with WF.

Table I Curing characteristics of NR/CSM rubber blend compounds (80:20) filled with different coratio of carbon black and wood flour (CB/WF)

Filler content CB/WF (phr)	Curing characteristics					
	MU(1+4) at 373K	Scorch time (min)	Ml (dNm)	Mh (dNm)	Cure time (min)	CRI $(100/ t_{c90}- t_{s2})$ min^{-1}
0/0	28	2.5	3.9	27	6.4	26
10/0	25	2.5	3.5	30	7.4	20
20/0	30	2.5	4.5	36	7.9	19
30/0	36	2.2	5.8	43	8.5	16
40/0	47	2.1	8	51	9.4	14
50/0	55	2.0	9.8	55	5.8	26
30/10	28	2.2	4.9	47	7.3	20
30/20	28	2.2	5.2	50	5.6	29
30/30	29	2.1	5.3	55	5.7	28
30/40	32	2.2	5.7	59	5.6	29
30/50	33	2.1	6	61	5.4	30

It is estimated that the scorch time (t_{s2}) and cure rate (t_{c90}) are reduced substantially by addinfg fillers. Wood flour particles are non-reinforcing filler[2]. With the presence of resin, the interaction between the filler and rubber matrix is increased while the carbon black content increases could be due to the agglomeration of particles in the rubber matrix. The effects of thermal aging and two different radiation doses (212 and 400 kGy) of WF and CB filled NR/CSM compounds with FP resin on the tensile strength are shown on fig. 1. The incorporation of CB and WF with resin has influenced the chemical bonds between both: carboxyl group of CB and rubber matrix, and hydroxyl groups of the WF and the rubber matrix via hydroxymethyl group of resin [3]. Thus the polymer-filler interaction are improved and imparted better tensile strength. Ageing for 3 days at 70°C results in

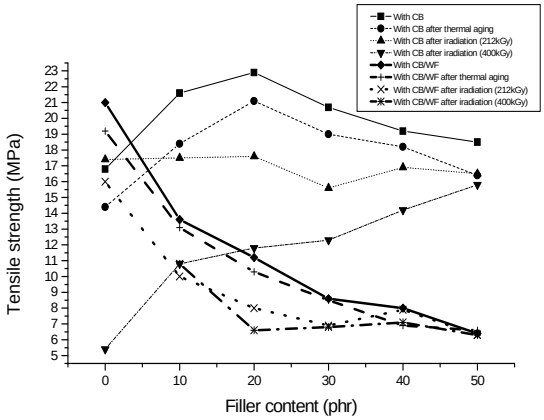

Fig. 1. Variation in tensile strength of CB and WF filled NR/CSM rubber blends before and after thermal and radiation aging

a decrease of tensile strength at all filler loadings. During thermal ageing the composite gradually loses their tensile strength due to degradation. At a radiation dose of 212 kGy, the variation of tensile strength are lower, due to the covalent bonds formed at the interface (through the reactive sites created by the radiation). When the radiation dose is increased to 400 kGy, the variation in properties is greather, and decreases continuously with CB and WF loading.

Conclusion

Compared to CB filled NR/CSM rubber blend, WF filled rubber blends have smaller changes of mechanical properties after thermal ageing. Ageing of elastomeric composites slightly increased the tensile strength due to the continued crosslinking reaction. The radiation degradation is predominates in the case of 400kGy radiation dose.

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