Enhanced Properties of Rubber Blends Through Controlled Distribution of Ingredients

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Introduction

Blending of polymers is largely done with the aim of obtaining new materials with a specific set of properties at minimum cost. Blends of elastomers are used for many applications. Furthermore rubbers are hardly used in their pure form. They are commonly mixed with reinforcing and non-reinforcing fillers, plasticisers, antioxidants and vulcanizing agents to provide required physical properties and to bring about an optimum level of vulcanization. The distribution of the fillers and curatives in rubber blends is an important criterion in obtaining optimum properties, as each rubber in the blend has its own specific package for fillers and curatives. Hence for obtaining optimum properties on blending the following criteria have to be fulfilled

1. Proper distribution of fillers over the two phases
2. Equal cure speed and level of cure of the two rubber phases

The problem

When rubbers with different levels of unsaturation or polarity are blended together

a) vulcanization ingredients preferentially end up in one phase, leading to overcure of one phase and undercure of the other (fig.1)

b) reinforcing fillers are unevenly distributed between the phases, resulting in over reinforcement of the one phase and a lower degree of reinforcement of the other (fig. 2&3)

This uneven distribution of fillers and curatives influences the properties of the vulcanised blend appreciably.

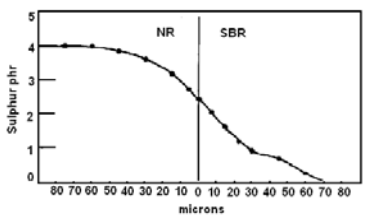

Fig.1 Diffusion of sulphur from NR to SBR at 150°C, 9secs

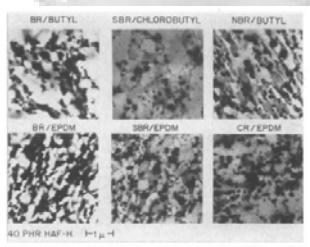

Fig.2 Electron micrographs showing carbon black distribution in 50/50 blends of high and low unsaturated elastomers

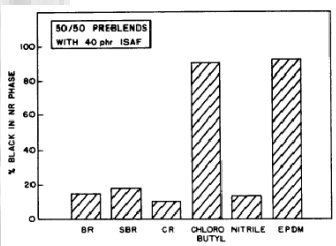

Fig. 3 Carbon black distribution in blends of NR with different elastomers

Aim of the project

Modification of the surface of fillers and curatives by plasma coating technique(ref.1) in order to tailor the surface properties of the fillers and curatives to achieve a better compatibility with the matrix. By this modification the fillers and curatives can be made hydrophobic or hydrophilic to accurately match the surface energies of the rubber in the blend. This can direct the fillers and curatives to the respective phase where they have to arrive in the blend, thus solving the reinforcement and cure mismatch problems.

Route

1. Evaluation of rubber blends with fillers and curatives in selected systems with respect to the distribution and filler -elastomer interaction.

2. Plasma surface modification of fillers and curatives

3. Elucidating the behaviour of plasma modified fillers and curatives in rubber blends

The plasma coated powders will be characterized in terms of coating thickness and surface energy. FTIR, TEM, and thin film interferometry will be used for characterization of coated particles. Inverse Gas chromatography will be used for the surface energy measurements and for elucidating the filler elastomer interaction.

Plasma Polymerization

In this process, thin polymer films are deposited on the surface of the substrates. The growth of low molecular weight monomers to high molecular weight polymers occurs with the aid of plasma energy.

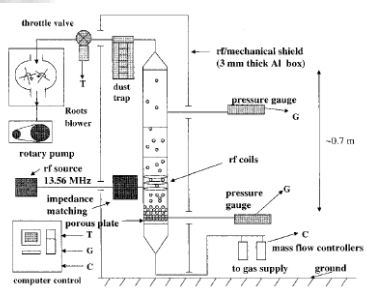

Fig.4 Schematic representation of a plasma reactor with fluidized bed

Project Partners

References

1. W.J.van Ooij and Aditya Chityala, 2nd International conference on Plasma Polymerization, Newark, NJ, May, 1999.