

Electric charge partition in polymer latex blends

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Abstract – Polymer latex films and their blends were analyzed by scanning electrical potential microscopy (SEPM), revealing the occurrence of electric charge partition between the blends constituents. The resulting electric potential difference contributes improving the compatibility between the phases through electrostatic adhesion, imparting outstanding mechanical properties to the blends.

Electric charge segregation has been observed for different insulating polymer films and the factors responsible for the formation of domains are chemical heterogeneity, segregation of oxidized chains, immiscible catalyst residues and contaminants, as well as differences of dielectric constant between amorphous and crystalline polymer domains.^{1,2} Electric charge partition between coexisting phases in insulator polymer blends has not been described in the literature. Charge segregation may affect blend properties, contributing for the blend cohesion through electrostatic adhesion.³ In this work, natural rubber (NR)/poly(styrene-butyl acrylate) (P(S-BA)) latex blends were examined by scanning electrical potential microscopy (SEPM), revealing electric charge partition between the phases. Blend mechanical properties were also measured.

Latex blends were prepared by mixing the latices in different proportions at room temperature and air-dried at 60 °C for 24-48 hours. Cut surfaces of the bare polymers and blends were obtained using cryoultramicrotomy at –150 °C.

SEPM image from the interface of the polymer films dried separately (Fig. 1a) shows that NR film presents small negative domains dispersed in a positive continuous phase while P(S-BA) is electrically more uniform and negative. SEPM image from the NR/P(S-BA) 7:3 (% wt.) blend (Fig. 1b) shows two phases with extensive interfacial domains, evidencing phase compatibility. A potential difference above 6 V is observed between the two phases. The negative matrix is NR and the positive dispersed phase is P(S-BA), determined by acquiring elemental maps by transmission electron microscopy (TEM). This potential contrast is the opposite of the polymers dried separately, allowing to conclude the occurrence of electric charge partition between the phases. Possibly, cations from natural rubber migrate to the P(S-BA) domains, whereas major of anions are attached to the polymer chains. Preliminary calculations show that cation migration may be due to the difference in dielectric constant between the two phases.

The mechanical performance of the blends was analyzed and the mechanical property values are given in Table 1. The increase of P(S-BA) content in the blends has a marked influence on the natural rubber mechanical properties, increasing the tensile strength and Young modulus by 2.5- and 60-fold, respectively, for a NR/P(S-BA) blend containing 50 % wt. of each polymer, showing values even superior to the separate polymers. This behavior indicates potential difference between the phases should contribute to increase the polymer compatibility, improving the cohesion between the different domains through electrostatic adhesion³, resulting in huge changes in the mechanical properties.

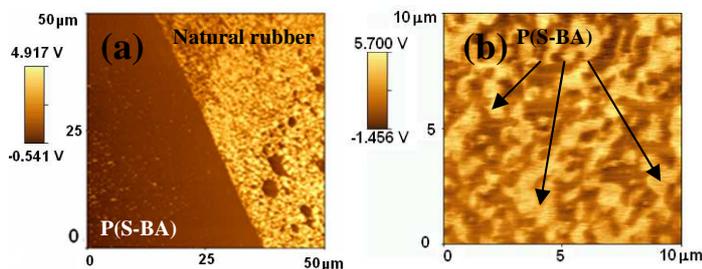


Figure 1: SEPM images from cut surface of (a) the interface of natural rubber and P(S-BA) films dried separately and (b) the natural

Table 1: Mechanical properties of natural rubber, P(S-BA) and NR/P(S-BA) blends.

Material	Tensile strength (MPa)	Modulus (MPa)
NR	1.2 ± 0.3	1.0 ± 0.5
P(S-BA)	4.0 ± 0.6	61 ± 7
NR/P(S-BA) 8:2 (% wt.)	0.73 ± 0.01	6.2 ± 0.6
NR/P(S-BA) 7:3 (% wt.)	2.0 ± 0.1	18 ± 2
NR/P(S-BA) 6:4 (% wt.)	3.0 ± 0.3	20 ± 3
NR/P(S-BA) 5:5 (% wt.)	4.27 ± 0.09	64 ± 7

References

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