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Characteristics of Wood Sawdust/EPDM Rubber Composites Processed by Irradiation

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The obtaining and characterization of polymeric composites based on wood sawdust and ethylene-propylene–terpolymer rubber are presented. The effects of cross-linking produced by classic method using benzoyl peroxide at high temperature and electron beam irradiation at room temperature are comparatively showed. The cross-linking effect produced by electron beam irradiation in the dose range of 75 kGy to 600 kGy has been shown to be superior to classic method using benzoyl peroxide in terms of rubber-filler interaction.

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PACS/topics: composites, sawdust, irradiation, dose, properties

1. Introduction

The reinforcing rubbers present improved mechanical and thermal properties as well as reduced cost [1]. Ethylene-propylene–terpolymer rubber (EPDM) is the rubber that has attracted much attention for outdoor applications due to its ability to accept high loading of fillers and strong resistance to oxygen, ozone, UV and heat [1]. Natural fibers is a class of renewable materials that experiencing nowadays a great revival [2, 3]. The wood sawdust (WS) is considered a good active fillers substitute [4, 5]. WS based composites are of interest due to the advantages over synthetic fiber composites: low density, favorable processing properties and occupational health benefits. The use of electron beam (EB) irradiation for cross-linking and grafting of elastomers has become more and more attractive. The process is very clean, the energy consumption is small, permits high processing speeds and operates at ambient temperature [5, 6]. The goal of the paper is to obtain and characterize a polymeric composite based on WS and EPDM.

2. Materials and equipments

The following raw materials were used: EPDM rubber Nordel 4760, polyethylene glycol PEG 4000, antioxidant Irganox 1010 and WS as filler (mesh 250–270). Cross-linking was realised using as vulcanizing agent for classic vulcanization dibenzoyl peroxide (PE) Perkadox 14–40B. The samples irradiation was performed in atmospheric conditions at room temperature of 25 °C, using the ALID 7 linear electron accelerator of 5.5 MeV. The EB dose rate was fixed at 5 kGy/min in order to accumulate doses between 75 and 600 kGy. The sol-gel analysis, crosslink density, mechanical characteristics and water uptake tests were performed according to previous studies [2, 5, 6].

3. Results and discussion

The gel fraction variation as a function of irradiation dose is presented in Fig. 1a for samples with and without

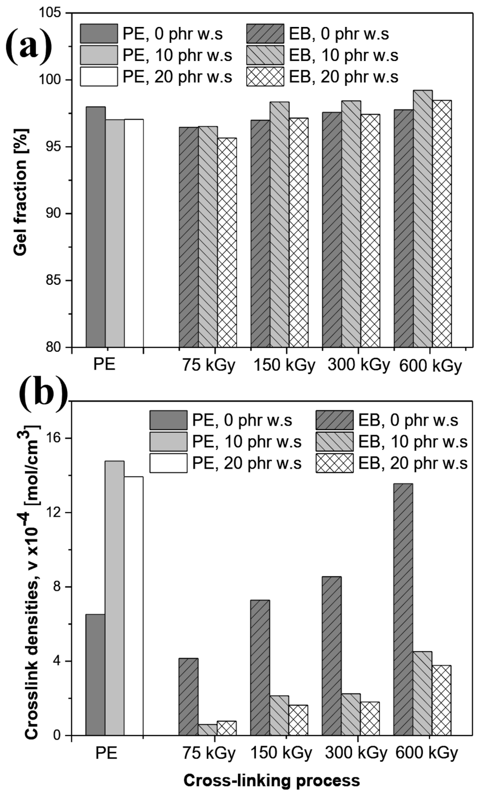

Fig. 1. The effect of the irradiation dose and WS amount on the gel fraction (a) and cross-link density (b) compared with samples cross-linked with PE.

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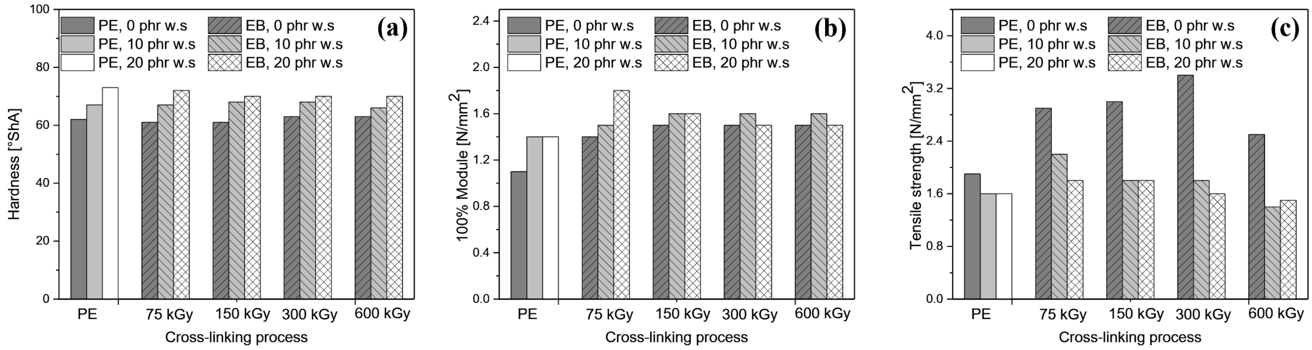

Fig. 2. The variation of mechanical properties as a function of WS amount and cross-linking process type (PE cross-linking versus irradiation cross-linking): (a) hardness, (b) 100% modulus, (c) tensile strength.

PE and WS. For samples containing only 10 phr of WS, the gel fraction values increase with the irradiation dose, the best result being obtained at 600 kGy. The addition of 10 phr of WS to the samples containing PE has conducted to the obtaining of the best values of cross-link density. From Fig. 2 it can be seen that the mechanical properties are modified by the increasing of the WS amount and irradiation dose, compared with samples cross-linked with PE. Hardness showed a small variation with WS amount and irradiation dose as in the case of PE cross-linking [7]. Both 100% modulus and tensile strengths increased with the increasing of the irradiation dose and WS amount due to the occurrence of a strong interface and to the close packing arrangement in the composite [7]. Also, 100% modulus increase with the WS amount indicates a good interaction between rubber and filler.

4. Conclusion

Even if the cross-link density of samples obtained by EB irradiation was small, the mechanical properties, excepting the hardness, were better than for the samples processed by the classic method using PE due to the cross-linking between rubber and filler. The same effect was highlighted by the water uptake experiments, in which the samples processed by EB irradiation have presented less water absorption than those processed by the classic method.

Tensile strength was improved by EB irradiation and also by the incorporation of WS in the rubber matrix. The water uptake increased with the WS amount and irradiation dose (Fig. 3), due to the hydrophilic nature of WS and to the bigger interfacial area between the WS and rubber matrix [8].

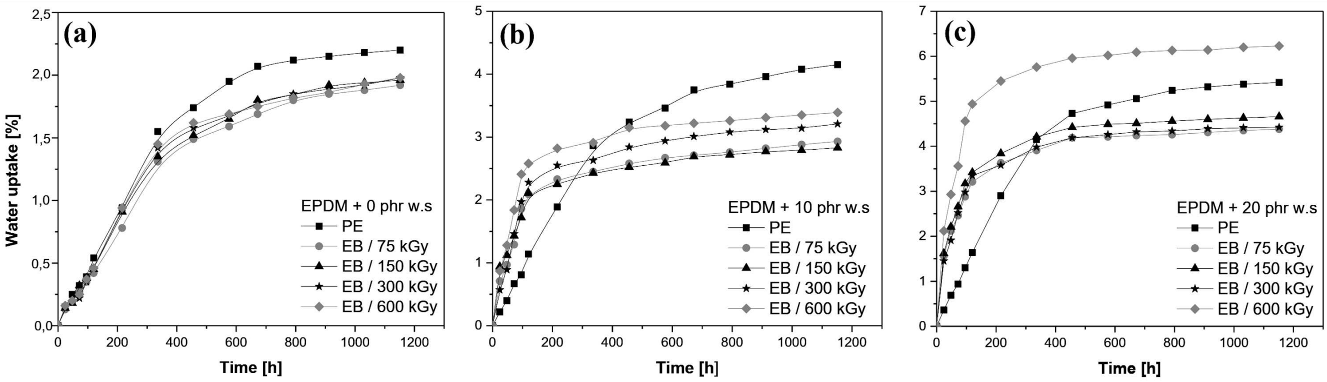

Fig. 3. The water uptake dependence on the amount of WS and irradiation dose presented for: (a) EPDM, (b) EPDM/10 phr WS, (c) EPDM/20 phr WS.

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