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Green technology fabrication of micrographite/rubber/hydrocolloid conductive composites

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Fabrication of conductive elastomers by fully green processing of a new material composed by micrographite, natural rubber, cellulose and hydrocolloids is reported in this work. Good dispersion of micrographite in a cellulose-hydrocolloid-elastomeric matrix without vulcanization was obtained. The conductive rubber composite has an electrical conductivity near 10-3 S/m. The advantages of obtaining this green conductive rubber includes reduction of production energy cost, development of a product under environmentally friendly process conditions and use of abundant raw materials. Micrometer graphite powder (Micrograf®, particle size 3 µm, G3) was provided by Nacional de Grafite Ltda (Brazil). Brazilian natural rubber, Heveabrasiliensis (solid content: 60 wt%, provided by Colitex®, Brazil) was the polymer matrix used in this study. Carboxymethylcellulose sodium (CMCNa) was purchased from Denver Cel (USA). As hydrocolloids, Plantago major seeds (Pms) and Plantago ovata powder (Psyllium, Pop) were used. Aqueous suspensions of 2 % (w/v) sodium carboxylmethyl cellulose were blended with natural hydrocolloid suspensions and, subsequently, with graphite microcrystals with lateral dimensions of about 3 µm and thicknesses of a few hundreds of nm (100-300 nm). The mixtures were produced at room temperature, using CMCNa, hydrocolloid and graphite with concentrations of 53 %, 14 %, 12 % (w/w), respectively. After the mixture reached homogeneity, natural rubber in a liquid form (17 %, w/w) was added and the final mixture was poured onto Petri plates. The product was dried overnight at atmospheric conditions being peeled off after 24hs. No vulcanization process was applied for the fabrication of the elastomer. The morphology of the nanocomposites was studied using Scanning Electron Microscopy (SEM) and the electrical conductivity was measured in a four probe configuration. Physical appearance of hydrocolloid suspension with Plantago was clear, transparent and slightly viscous and the mixture solutions obtained further with CMCNa and micrographite presented a good homogeneity. Control films formed by mixture of natural rubber with hydrocolloid and CMCNa were prepared and dried at room temperature for 15 to 30hs. Scanning electron microscopy showed relatively rough surface for both composites (with and without micrographite), the films presenting a high homogeneity over its width and thickness. Filling of nanocomposites with conductive components has a significant impact on the electrical conductivity of the resulting material. As expected, the graphite-free material has extremely high resistivity while the material containing micrographite showed very promising results, with the electrical resistance in the range between 60 and 600 Ohms measured for samples with lateral dimensions of 3x3 cm and thickness of 1 mm, and electrical conductivity as high as ~10-3 S/m, comparable with the best results reported in literature for conductive elastomers.