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ORIGINAL PAPER

Thermal properties and aging characteristics of chemically modified oil palm ash-filled natural rubber composites

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Abstract The chemically modified oil palm ash (OPA) with the cetyltrimethylammonium bromide (CTAB) solution was prepared prior to compounding with the natural rubber and other curing ingredients. The aging resistance and thermal stability of CTAB-modified OPA-filled natural rubber composites were evaluated in the same manner as non-modified OPA samples. The retention tensile properties after thermal aging was measured and based on the result shown, the CTAB-modified OPA-filled natural rubber composites imparted insignificant effect to aging resistance as compared to the non-modified OPA-filled natural rubber composites at very low OPA loading; however, the effect became apparent beyond 3 phr OPA loading where the CTAB-modified OPA-filled natural rubber composites provided better aging resistance than the corresponding non-modified OPA-filled natural rubber composites. The thermogravimetric analysis indicated that the CTAB-modified OPA-filled natural rubber composites exhibited lower thermal stability which showed lower temperature at their respective weight loss and lesser char residue than that of non-modified OPA-filled natural rubber composites. This was attributed to the CTAB which started to decompose at the temperature of 210 °C. However, for the range from ambient temperature to 210 °C, the CTAB-modified OPA-filled natural rubber composites produce better thermal stability than those of non-modified OPA-filled natural rubber composites.

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Keywords Oil palm ash · Cetyltrimethylammonium bromide · Natural rubber · Aging · Thermal

Introduction

Natural rubber (NR) offers excellent elastic properties, impact resistance, resilience and abrasion resistance which make it dominant in many engineering products such as hoses, footwear, tires, conveyor belts and etc. In addition to the mechanical properties of natural rubber composites, the attention was also focused on thermal aging resistance [1] as NR encounters a major change when it is exposed to high thermal and oxygen environments, especially ozone since the ozone could cause surface cracking by rapid penetration which leads to the deterioration in physical and mechanical properties of vulcanized natural rubber [2]. This could be overcome by incorporation of additives to improve the thermal aging resistance of NR composites.

Recently, the utilization of agricultural waste has attracted interest owing to their inexpensive, renewable and highly abundant materials. In Malaysia, palm oil is one of the important socio-economic commodities due to its high supply and demand prospect. According to Zwart [3], the oil palm plantation covered about 5 million hectares and yielded 18.91 million metric tons of crude palm oil in year 2011. In turn, there is estimated 80 million metric tons of dry weight biomass (i.e., empty fruit bunches, kernel shells, fronds, trunks and etc.) and partially used as alternative feedstock for energy production in the form of electricity and heat. The by-product produced from the combustion, i.e., oil palm ashes (OPA) is highly abundant and normally legally or illegally dumped on open field and disposed in landfill.