UNIVERSITI TEKNOLOGI MARA

MECHANICAL AND THERMAL PROPERTIES OF RUBBER TOUGHENED POLYESTER FILLED CARBON BLACK (CB) AND KENAF HYBRID COMPOSITE

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ABSTRACT

This study was conducted to investigate the mechanical and thermal properties which are flexural strength, flexural modulus, impact strength, fracture toughness, storage modulus, tan delta, curing behaviour, decomposition temperature, glass transition temperature, followed by chemical interaction and morphological properties of rubber toughened composites. Neat polyester, rubber toughened polyester (RP), rubber toughened polyester composite filled carbon black (RPCB), rubber toughened polyester filled CB and treated kenaf (RPCBTK) and rubber toughened polyester filled CB and untreated kenaf (RPCBUK) hybrid composite were produced. Carbon black (CB) nanopowder and kenaf fibres were dried and sieved. A part of kenaf fibres was treated by using 6 wt. % of sodium hydroxide (NaOH). CB filler was varied from 2, 4, 6, 8 and 10 wt. %. Treated and untreated kenaf fibres were varied from 5, 10, 15, 20 and 25 wt. %. 3 wt. % of liquid natural rubber (LNR) was added as the toughening agent. RPCB composites were prepared using open mould technique. Kenaf hybrid composites were prepared by using hot compression method.4 wt. % of CB filler was chosen as the overall optimal filler percentage and combined with each percentage of treated and untreated kenaf fibre to produce rubber toughened polyester hybrid composites. The composite properties were investigated by using flexural, impact, fracture toughness, differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), dynamic mechanical analysis (DMA), fourier transform infrared spectroscopy (FTIR), field emission scanning electron microscopy (FESEM), energy dispersive x-ray spectroscopy (EDX) and transmission electron microscopy (TEM) testing. For RPCB composites, neat polyester gave the maximum value for flexural strength (56.13 MPa). 4 wt. % of RPCB composite gave the maximum value of 5.51 GPa for flexural modulus and 7.05 kJ/m^2 for impact strength.For RPCBTK and RPCBUK hybrid composites, neat polyester gave maximum flexural strength value. 25 wt. % of RPCBTK gave maximum flexural modulus of 6.31 GPa. RPCB composite gave the maximum impact strength while RP composites gave maximum fracture toughness value of 1.87 MN/$m^{3/2}$. 25 wt. % of RPCBUK and 25 wt. % of RPCBTK were chosen as the overall optimal percentage of hybrid composites. 25 wt. % of RPCBTK gave optimal maximum value of 53.73 MPa for flexural strength, 3.57 kJ/m^2 for impact strength and 1.20 MN/$m^{3/2}$ for fracture toughness. 25 wt. % of RPCBUK gave optimal maximum value of 37.44 MPa for flexural strength, 5.83 GPa for flexural modulus, 3.41 kJ/$m^2$for impact strength and 1.71 MN/$m^{3/2}$ for fracture toughness. 25 wt. % RPCBUK gave maximum storage modulus value of 42.86 GPa. 25 wt. % RPCBTK gave the maximum glass transition temperature of 116.067 C° and lowest tan delta intensity of 0.24. TGA thermograms showed good decomposition behaviour of the composites. DSC thermograms showed composites were fully cured. FTIR spectra indicated the removal of hydroxyl groups by NaOH in the treated hybrid composite. FESEM micrograph showed good interfacial bonding between rubber, CB particles, kenaf fibre and polyester matrix. Changes in weight percentage of elements from EDX analysis indicated presence of rubber, CB particles and kenaf fibre in the matrix. TEM micrograph of RPCB composite showed the presence of 3 to 8 nm sized of CB particles in the composite.

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TABLE OF CONTENTS