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Thermal, Dynamic Mechanical, Mechanical and Flammability Properties of Halloysite Nanotubes Filled Polyamide 11 Nanocomposites

(2023) *Malaysian Journal of Fundamental and Applied Sciences*, 19 (2), pp. 173-193.

DOI: 10.11113/mjfas.v19n2.2684

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Abstract

The effects of various filler contents on the thermal, dynamic mechanical, mechanical, as well as flammability properties of halloysite nanotubes (HNTs) filler and polyamide 11 (PA 11) matrixes are investigated in this research. The nanocomposites were made out of 100 phr of PA 11 and three distinct HNTs loadings of 2, 4, and 6 phr each. PA 11 nanocomposites without HNTs filler was used as the reference sample. To melt-compound the nanocomposites, a twin-screw extruder was used, and the specimen for testing was then injected using an injection mold. SEM, TGA, DSC, FTIR, DMA, tensile, flexural, impact, and UL-94 flammability tests were conducted on the nanocomposites. Incorporation of 4 phr HNTs into the nanocomposites resulted in the highest tensile and flexural strength. Maximum improvement in the DMA, Young's and flexural modulus was achieved at 6 phr HNTs content. The elongation at break and TGA resulted the highest increase at 2 phr HNTs content. However, the impact strength decreased with increasing HNTs content. Scanning electron microscopy revealed the ductility of the nanocomposites with increased HNTs content up to 4 phr. The DSC showed a steady increase in melting temperature (Tm) as HNTs content increased up to 4 phr, while the crystallization temperature (Tc) remained unchanged. TGA of PA 11/HNTs nanocomposites showed high thermal stability at 2 phr HNTs content. However, on further addition of HNTs up to 6 phr, thermal stability of the nanocomposites decreased due to the excess amount of HNTs. All the nanocomposites passed the horizontal and vertical UL-94 test with HB and V-2 grade. PA 11/4HNTs nanocomposite has the highest tensile strength, flexural strength compared to other PA 11/HNTs nanocomposites. PA 11/4HNTs nanocomposite can be suggested as an optimum formulation with balanced mechanical properties in terms of toughness. © 2023 The Korean Association for Radiation Protection.

Author Keywords

flammability properties; Halloysite nanotubes; mechanical properties; nanocomposites; Polyamide

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HAL Id: hal-02892647

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Publisher: Penerbit UTM Press

ISSN: 2289599X
Language of Original Document: English
Abbreviated Source Title: Malaysian J. Fundam. App. Sci.
2-s2.0-85158837611
Document Type: Article
Publication Stage: Final
Source: Scopus