Materials Today: Proceedings 51 (2022) 1288–1292

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Intumescent flame retardant coating based graphene oxide and halloysite nanotubes

Siti Maznah Kabeb [a], Azman Hassan [b], Zurina Mohamad [b], Zalilah Sharer [b], Faiz Ahmad [c]

[a] Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, Gambang, Kuantan, Pahang 26300, Malaysia
[b] Department of Bioprocess and Polymer Engineering, Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia, Skudai Johor 81310, Malaysia
[c] Department of Mechanical Engineering, Universiti Teknologi Petronas, Seri Iskandar 32610, Perak

ARTICLE INFO

Article history:
Available online 12 November 2021

Keywords:
Intumescent
Non-flammable
Coating
Carbon
Nanoclay

ABSTRACT

Epoxy nanocomposites coatings filled with hybrid graphene oxide/halloysites (GO/HNT) based intumescent flame-retardant additives (IFR) have been fabricated and investigated in terms of flame retardancy property, thermal stability, and adhesion strength. The dispersion and interaction of the nanofillers with the matrix were characterized by transmission electron microscopy (TEM) and Fourier transform infrared (FTIR). The synergistic flame-retardant effects of ammonium polyphosphate (APP) on flame retardancy properties and thermal stability were investigated by limiting oxygen index (LOI) and thermogravimetric analysis (TGA), respectively. The result shows that the epoxy coating with hybrid GO/HNT based IFR achieve an LOI of 26 % at 1 phr of APP (EGO0.6H0.3APP1). Meanwhile, the maximum mass loss of the EGO0.6H0.3APP1 coating sample is 391.0 °C which showing an increment by 1.3 % compared with neat epoxy coating, demonstrating excellent thermal stability performance. The char residue also suggests, APP played a synergistic flame-retardant mechanism with a combination of hybrid GO/HNT. The presence of hybrid GO/HNT/IFR considerably enhances adhesion strength between the coating material and metal substrate. The EGO0.6H0.3APP1 showed the maximum LOI value, thermal stability, and adhesion strength among the studied formulations.

Selection and peer-review under responsibility of the scientific committee of the 3rd Symposium on Industrial Science and Technology 2021

1. Introduction

Structural steel loses a considerable part of its load carrying capacity and would typically fail when the steel reaches temperatures between 500 and 600 °C. Preventing the structural collapse of buildings is essential to ensure the structural integrity and safe evacuation of people from buildings, which is the primary requirement of building regulations in many countries/regions. For environmental concerns, intumescent flame-retardant (IFR) is considered as a promising halogen-free flame retardant additive due to its advantages of low smoke, low toxicity, low corrosion, and no molten dripping during a fire [1].

IFR coatings are designed to protect substrates against fire and maintain their structural integrity between 1 and 3 h when the temperature of the surroundings is more than 1100 °C, whilst at the same time maintaining aesthetic appearance [2]. IFR protection has been used since about 50 years ago, whereas incorporating intumescent additives in polymeric materials is a relatively recent approach [3]. The previous study showed that the addition of HNT and polydimethylsiloxane (PDMS) in the coating formulations based IFR coatings (ammonium polyphosphate/melamine/-boric acid/expandable graphite, APP/MEL/BA/EG) resulted in better heat shielding developed silicate network over the char surface and the decreased thermal decomposition rate of residue carbon during the intumescent reaction [4]. Ullah et al [5] demonstrated the role of multiwall carbon nanotubes (MWCNT) in char strength and flame-retardant property of epoxy based IFR coating by sealing or physically joining the cracked char layers together.

The present study aims to investigate the synergistic effects of hybrid GO/HNT based IFR on the thermal stability and flammability performance of epoxy nanocomposite coating. Moreover, the effect of ammonium polyphosphate (APP) loading which acts as a charring or carbon source on flame retardancy as well as thermal decomposition behavior were investigated in detail to explain the flame-retardancy and char formation mechanisms.

https://doi.org/10.1016/j.matpr.2021.10.321

Selection and peer-review under responsibility of the scientific committee of the 3rd Symposium on Industrial Science and Technology 2021