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High performance ceramic-based phthalonitrile micro and nanocomposites

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Abstract

The current review discusses the effects of adding various types of ceramic fillers on the curing behavior, thermal, mechanical, anticorrosion, and UV shielding properties of the bisphenol-A based phthalonitrile resins. The effects of different ceramic filler contents and sizes as well as their surface treatments are also discussed in terms of their impact on the morphology and mechanisms of enhancement. The synergistic effect obtained by these combinations extends the use of the phthalonitrile resins to more exigent applications such as aerospace and military. The presented results reveal the significant advantages that can be obtained from the preparation of hybrid materials based on phthalonitrile resins and open the way for further research in the field.

Keywords: Ceramics, Polymeric composites, Nanocomposites, Polymers.

1. Introduction

Advances in technology demand either new materials or improvements of the already existing ones. The preparation of hybrid materials through the synergistic combination of polymers and ceramics is an example of an approach that led to the emergence of a new class of materials. The obtained materials are known as micro or nanocomposites according to the ceramic filler sizes. Considering the numerous kinds of possible combinations between both ceramics and polymers, the resulting material properties can be tailored according to the desired applications. Recent developments in monomer designs have led to the appearance of a new class of high performance polymer materials, and as a result, a way for further progress in hybrid materials was opened.

Phthalonitrile resins, as newly developed high performance polymer materials, are well-known for their outstanding thermal stabilities, good mechanical properties, low water absorption, absence of a glass transition temperature (T_g) before their thermal decomposition, and superior flame resistance [1-7]. All these striking properties extend the use of these resins in producing various kinds of high performances composites suitable for different industrial applications, such as aerospace, marine, and microelectronic packaging. However, the phthalonitrile resins suffer from some shortcomings related their high brittleness and limited impact strength for hard applications. To overcome these problems, different solutions were explored such as the synthesis of new