Nanocomposite, an innovative route to large structure and infrastructure protection. A case of study: CNT-doped polyurea.

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Summary

In this work we focus on experimental studies of polymer-nanocomposites intended for passive protection of civil structures. The material consists of a polyurea-matrix enhanced by different quantities of multiwalled carbon nanotubes. Several tensile and cyclic tests are performed to evaluate and characterize the mechanical behaviour of this new material. Furthermore, we subject the material to accelerated thermal aging and study its performance deterioration which is fairly unknown. The results on the unaged specimens are intuitive and indicate that an arbitrary amount of CNTs may result in suboptimal performance. More specifically, 1% in weight of CNTs yields the best mechanical performance. However, after a long aging term, our findings are interesting and counterintuitive as these nanocomposites become more brittle and break quickly while the virgin polyurea gives the best performance.

Keywords: nanomaterials, carbon nanotubes, polymer matrix, composite materials, polyurea, accelerated aging, thermal loading.

1. Introduction

In many urban cities, counties and states, the infrastructural system suffers from different problems such as corrosion in steel and reinforced concrete structures, deterioration of structural elements due to climate and environmental changes, damage induced by wind or earthquake excitations or by man-made actions, aging of materials etc.. These problems require continuous monitoring, repairs, strengthening and replacement of damaged components, all actions that require significant resource allocation for maintenance [1, 2, 3]. Recently, the production and use of nanoparticles has become a major research theme worldwide as an innovative route to solve part of these problems [4]. Many applications of these nanoparticles rely on their incorporation into a host matrix which form the so called "nanocomposites", which are multiphase solid materials with at least one phase on the order of nanometre. Recent studies on polymer nanocomposites with carbon nanotubes have shown that tremendous changes in mechanical and chemical properties can be achieved in these systems compared to analogous materials with micron/nano scale structures and the matrix properties are significantly affected in the vicinity of the reinforcement [4-6]. In particular, application of Polyurea coatings, which is relatively inexpensive, flexible, weathering and abrasion resistant, and extremely easy to apply to structures via spray coating may be used as a binding matrix for carbon nanotubes and suited for civil, aerospace and naval structures [7]. Our goal in this work is to reinforce Polyurea with carbon nanotubes and find the optimal amount of enrichments that will yield the best mechanical performance as well as understanding how it performs under thermal loading.

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