Chapter 26
Aeronautical Impact of Epoxy/Carbon Nanotube Nanocomposite

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ABSTRACT

Epoxy resin has been employed as an important matrix for aerospace composite and nanocomposite. In this chapter, latent and essential features of carbon nanotube (CNT) nanofiller have been considered with reference to aeronautical application. Consequently, epoxy/carbon nanotube nanocomposite are conversed here for space competency. Inclusion of CNT in epoxy resin affected the prerequisite features of space nanocomposite. Dispersion of nanotube has been altered using suitable processing technique. Uniform nanotube network formation affects mechanical, electrical, and other physical properties of nanocomposite. Key application areas in this regard are flame and thermal stability, strength, lightning strike resistance, and radiation shielding of space vehicles. Further investigations to optimize structure and properties of multiscale epoxy/CNT nanocomposite are needed for future success in the field. Hence, towards the end, challenges and future prospects of epoxy/CNT nanocomposite have also been deliberated for the improvement of nanomaterial properties for aerospace relevance.

INTRODUCTION

Nanotechnology advancements have led to several developments for technical applications. Design and properties of polymeric nanocomposite for aerospace structures have significant effect on aerospace applications. Thus, aerospace design has been made safer, faster, and cheaper compared with the conventional space transportation. Polymer nanocomposite have at least one dimension in range of 1-100 nm, i.e. offered by the reinforced nanoparticles (Bogue, 2011; Ogasawara, Moon, Inoue, & Shimamura, 2011). Pristine polymers have been used in aerospace applications, however thermal and mechanical design loads were found least compatible (Rao, 2003). Employment of polymer-based nanocomposite

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have been focused in space vehicles owing to superior characteristics (F. Hussain, Hojjati, Okamoto, & Gorga, 2006; Liu, Du, Liu, & Leng, 2014). Carbon nanotube (CNT) is an allotrope of carbon. It is a cylindrical carbon molecule having several useful properties for electronics, optics and other nanotechnology fields (R. Saito, Dresselhaus, & Dresselhaus, 1998). Various polymers have been reinforced with nanotube including polyaniline, polyamide, polyethylene, polystyrene, polyurethane, polycarbonates, epoxies, and several others (S. T. Hussain, Abbas, Kausar, & Khan, 2013). Solicitation of polymer/CNT nanocomposite has gained remarkable research and commercial curiosity (Kausar, Rafique, & Muhammad, 2016). Consequently, CNT-based polymeric nanocomposite have been employed in organic solar cell, light-emitting diodes, field emission devices, liquid crystal, sensors, electronics and biomedical field. Moreover, nanotube-strengthened polymeric nanocomposite have been used in armor, civil engineering, automobile, sporting goods and weight-sensitive aerospace industry (Kausar & Hussain, 2013; Khan, Kausar, & Ullah, 2016). Epoxy resin is a polyepoxide. It is a class of reactive prepolymer containing epoxide groups. Polyepoxide reacts with functional diamine or diol hardener to form a thermosetting polymer. Epoxy possesses superior mechanical, thermal, and chemical resistance. Epoxy has range of applications in adhesives, coatings, electrical components, electrical insulators, strengthened materials, etc.(Ellis, 1993; Levchik & Weil, 2004). Epoxy/carbon nanotube nanocomposite possess exceptionally high strength, fatigue resistance, conductivity, thermal stability, non-flammability, adhesion, and other desired perspectives for commercial application in aerospace industry (Rafique, Kausar, Anwar, & Muhammad, 2016). In this chapter, current potential of polymeric nanocomposite especially epoxy/carbon nanotube nanocomposite have been explored in aerospace industry. In this regard, essential aspects of polymer and epoxy-based nanocomposite have been deliberated. Applications of epoxy/carbon nanotube nanocomposite in various fields of aerospace technology have been systematically conversed (Lan et al., 2009; Pandey, Ahn, Lee, Mohanty, & Misra, 2010). Consequently, this chapter reviews essential features of polymeric nanocomposites for potential aerospace applications. Towards the end, challenges and potential of epoxy/carbon nanotube nanocomposite in aerospace have also been discussed considering future advancement.

BACKGROUND

Aeronautical Composite

In aerospace industry, composites are lightweight materials having high specific strength, stiffness, and impact characteristics. Particularly, nanofiber reinforced polymers possess excellent toughness, and fatigue and corrosion resistance. Furthermore, the high performance composite materials may reveal optimum mechanical properties by orientating nanofiber direction with the load transfer paths (Gay & Hoa, 2007; Shanyi, 2007). Polymeric systems with organic as well as inorganic nanofiller have gained attention for aerospace constituents and systems on commercial scale (Ahmed, Ikram, Kanchi, & Bisetty, 2018). Nanoparticles usually have high surface area per unit volume and unique structural features (Haque, Hossain, Dean, & Shamsuzzoha, 2002). Among organic fillers carbon fiber has been progressively employed in space craft and air craft industry. Carbon fiber-based composites are well known for light weight, low density, high strength, modulus, stiffness, and fatigue life. These nanocomposites have major advantages of low manufacturing cost, weight-less ness, and outstanding mechanical and physical features to substitute metals such as aluminum alloys in aerospace applications (Hirsch & Al-Samman,

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