Chapter 23
Scope of Polymer/ Graphene Nanocomposite in Defense Relevance:
Defense Application of Polymer/Graphene

Ayesha Kausar
https://orcid.org/0000-0003-2497-6115
National University of Science and Technology, Pakistan

ABSTRACT

This chapter outlines important aspects and progression from graphene to polymer/graphene nanocomposite to a relevant defense application. Graphene is unique nanocarbon material having a large surface area, high Young's modulus, thermal conductivity, electrical conductivity, and optical transmittance. Engineering thermoplastic polymers have been employed as matrices for graphene reinforcement. Various routes have been employed for graphene-filled polymeric nanomaterials. Intrinsic physical properties of nanocomposite depend on graphene modification and dispersion techniques. Polymer/graphene nanocomposite may have multifunctional characteristics due to synergistic effect of polymer/graphene. The article mainly discusses nanocomposite with potential uses in soldierly applications including flame resistance, ballistic protection, electromagnetic interference shielding, electrostatic-charge dissipation, sensors, corrosion protection, fuel cell, batteries, etc. The gestalt of defense applications of polymer/graphene nanocomposite may offer future perspective to develop promising materials.

INTRODUCTION

Several potential opportunities have been promised by nanotechnology for defence technologies. In this regard, various advantages have been explored for defence applications. Range of military platforms have been benefited from nanotechnoloy revolution (Kurahatti et al., 2010). In defense technology, power systems, sensing, stealth technology, aviation, marine, aerodynamics, etc., have frequently employed nanomaterials (Domun et al., 2015; Lyu & Choi, 2015; Nambiar & Yeow, 2012). Polymers alone have

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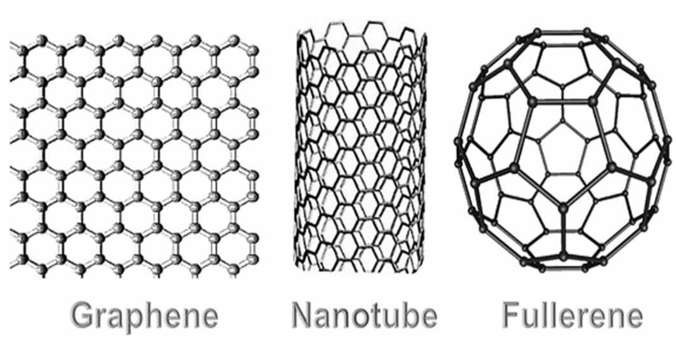
also been applied in defense applications (Kausar & Siddiq, 2016). However, more success has been achieved with nanomaterials. Design and fabrication of new nanomaterials having high performance multifunctional characteristics may result in amplified recital of defense sector (Singh & Wang, 2015). In polymer nanocomposite, small size of nanofillers may lead to large interfacial area between the matrix and additives. The interfacial interactions may control the dispersion of nanofiller in polymer, and thus control the final properties. Moreover, to implement the properties of nanocomposites, processing methods are important to control the particle size distribution and dispersion. Graphene is a nano allotrope of carbon with single layer of carbon atoms arranged in hexagonal lattice (Ferrari et al., 2006; Zhou et al., 2018). One of the important uses of graphene has been identified for polymer nanocomposite (Kausar, 2016a). Traditional nanofillers such as clay, fibers, and particles have been frequently replaced by this unique nanofiller (Kausar, 2014, 2016b). Several advantages of polymer/graphene nanocomposite have been explored for defense applications (V.C. Verma). Need of this technology in military relevance has been realized over a few decades. This chapter basically presents potential use of polymer/graphene nanocomposite in defense along with significant application areas. Moreover, challenges and opportunities in fabrication and use of polymer/graphene-based engineering materials for defense purposes have been considered. There is hardly any known review article available focusing the essential aspects of polymer/graphene nanocomposite for military applications. There is extensive need of a comprehensive chapter covering all possible aspects and applications of polymer/graphene nanocomposite in military relevance. The chapter presents not only the background related to graphene, polymer/graphene nanocomposite, fabrication, essential properties, and dispersion but also covers the applications ranging from ballistic and fire safety to biomedical applications.

BACKGROUND

Graphene: A Unique Nanocarbon

Graphene is an important type of nanomaterial with atomic thick hexagonally designed sheets of sp^2 hybridized carbon atoms (Mukhopadhyay & Gupta, 2012). It is a one-dimensional nanofiller having large surface area of 2630 m^2g^{-1} (Fig. 1). Its structure has been studied through several theoretical and experimental techniques. Graphene also possesses remarkably high Young's modulus, strength, and

Figure 1. Nanocarbon structure with different dimensionality



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