Chapter 5
Anticorrosive Carbon-Based Polymer and Epoxy Nanocomposite Coatings

Loutfy Madkour
https://orcid.org/0000-0002-3101-8356
Tanta University, Egypt

ABSTRACT

Carbon is used as a reinforcing phase in carbon-fiber reinforced polymer composites employed in aeronautical and other technological applications. Degradation of composite occurs under polarization in aqueous media. Epoxy-based coatings have gained significant research interest owing to sufficient hydrophobicity, conductivity, water transport behaviour, and corrosion resistance. Furthermore, the anti-corrosive polymer coatings with low nanotube content have shown enhanced surface hydrophobicity and anti-rusting properties in addition to strength, conductivity, and thermal resistance. Also, polymer base coatings assessing the strength of bonding of the coating to the substrate, and salt spray test are common. This book chapter highlights the potential corrosion challenges in multi-material combinations containing carbon-fiber reinforced polymers, the surface chemistry of carbon, its plausible effects on the electrochemical activity of carbon, and consequently the degradation processes on carbon-fiber reinforced polymers.

1. BACKGROUD

Most metallic structures degrade due to atmospheric corrosion, which is a major problem for bridges, pipelines, and storage tanks. Valença et al. (2015) reported ZnO nanoparticles/polypyrrole (ZnO–NPs/PPy) hybrid nanocomposites used as additives in an epoxy paint to protect SAE 1020 carbon steel from corrosion due to humidity, pollutants, and temperature. The physicochemical characteristics that may interfere with the corrosive action of the environment are the presence of water, salts, gases, differences in pH, and electrical conductivity. Riccardis and Martina (2014) reported conductive polymers with a good corrosion stability both in contact with solution and in the dry state, to minimize the health risk

DOI: 10.4018/978-1-6684-7689-5.ch005

to humans and damage to the environment. Batool et al. (2012) reported ZnO/PPy hybrid materials that have a variety of applications in optoelectronic devices and good anti-corrosion properties. Furthermore, Lehr and Saidman (2013) reported polypyrrole as an anticorrosive additive for steel coating.

Supercapacitors/ultracapacitors/electrochemical capacitors are energy storage devices. Yang (2011) described electrode materials made up of carbon-based nanomaterials, metal oxides/hydroxides, and conducting polymers; they are the most common electroactive materials for supercapacitors and exhibit very high power output and better cycling ability. Wu et al. (2010) reported that combining nanoscale dissimilar capacitive materials to form nanocomposite electroactive materials is an important approach to control, develop, and optimize the structures and properties of electrode materials for enhancing their performance for supercapacitors. There are still a lot of challenges to be overcome regarding the design and fabrication of nanocomposite electroactive materials for supercapacitor applications. Nanocomposite electroactive materials that have been developed so far have demonstrated huge potential. Lee et al.(2005) reported significant improvement in terms of specific surface area, electrical and ionic conductivities, specific capacitance, cyclic stability, and energy and power density of supercapacitors using nanocomposite electroactive materials.

Green nanocomposites are ecofriendly and sustainable in all ways and possess renewability and degradability, reducing and preventing pollution. Natural polymers such as cellulose, chitin, starch, polyhydroxyalkanoates, polylactide, polycaprolactone, collagen, and polypeptides are biodegradable.

Polymer-based nanocomposites containing insulating, semiconducting, or metallic nanoparticles are highly used in electronic and food packaging industries; e.g., nylon-6, polypropylene for packaging and injection-molded articles (nylon-6/surface-modified montmorillonite). They are also useful in tires, fuel systems, seat textiles, mirror housings, door handles, engine covers, timing belt covers, and pollution filters. Polymer/inorganic nanocomposites show good conductivity, permeability, and water management properties for use in water nanofilters (Gangopadhyay & Amitabha. 2000, Giannelis 1996, Fischer 2003 & Pandey et al. 2005).

Ecofriendly nanocomposites for better packaging materials are being developed. For example, the use of nanoclay particles in thermoplastic resins improves barrier properties and package survivability. CNT polymer composites can be used for data storage media, photovoltaic cells and photo diodes, optical limiting devices, drums for printers, etc. (Dresselhaus et al. 2001, Choi & Awaji 2005, and Ajayan et al. 2003). Nanocomposites are speeding healing process for broken bones: e.g., CNT/polymer nanocomposites and these nanocomposites conduct electricity and can be used as a stress sensor on windmill blades to alarm in case of excessive damage and then shut down to save the blade. Epoxy/CNT composite makes a windmill blade that is strong and lightweight. Graphene/epoxy composite is stronger and stiffer than CNT because graphene bonds better to the polymers in the epoxy; this property means this composite is suitable for windmill blades or aircraft components. In the biomedical field, a nanocomposite blend with magnetic and fluorescent nanoparticles makes tumor cells more visible during magnetic resonance imaging (MRI) (Breuer & Sunderraj 2004, Ke & Bai 2005, Presting & Konig 2003 and Swearingen et al. 2003).

The blending of two or more polymers to achieve a biodegradable nanocomposite polymer has been reported, e.g., starch/PLA blends, polybutylene succinate/CA blends, starch/modified polyester blends, polycaprolactone/poly(vinyl alcohol) blends, and thermoplastic starch/polyesteramide blends (Averous et al. 2000). Nanocomposites have been used in several applications such as mirror housings on vehicle types, door handles, door panels, trunk liners, instrument panels, parcel shelves, head rests, roofs, upholstery, engine covers, intake manifolds, and timing belt covers. Other applications currently being considered

Related Content