Studies on the Development, Characterization and Application of Nanocomposite Anticorrosive Coatings

Obaid ur Rahman

Department of Chemistry
Faculty of Natural Sciences
Jamia Millia Islamia, New Delhi

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ABSTRACT

Polymer nanocomposites represent an exciting and promising alternative to the pristine polymer or conventional composites or filled systems owing to the dispersion of nanosized fillers that impart markedly improved performance in mechanical, thermal, barrier, optical, electrical, and other physical and chemical properties to the final nanocomposite. Nanomaterials with an average grain size of 1-50 nm have attracted research interests for more than a decade, since their chemical, physical and mechanical properties are quite different from that of bulk micron-sized counterparts. The difference in properties is due to the large surface energy volume fraction of atoms that occupies more surface area. The incorporation of nanoparticles into polymeric resins can fill cavities and cause crack bridging, crack deflection and crack bowing enhancing the integrity and durability of coatings through adhesion between coating and metal surfaceand further improves the physico-mechanical and corrosion resistance properties of nanocomposite coating materials. Nanocomposites are considered as a new and versatile class of materials, offering potential applications in the field of paints and coatings.

In view of the significance of polymer nanocomposite coatings and their high industrial scope, present thesis describes the synthesis and characterization of soybean oil based polymer nanocomposite coatings. The soy bean oil (contains 54% linoleic acid) derived polymersare selected as renewable organic precursors and metal oxides as fillers for the preparation of polymer nanocomposites.

The thesis has been divided into the following five chapters.

<u>Chapter 1: Introduction and literature survey</u>

The present chapter discusses about the properties and applications of nanocomposite coatings, sustainable resource based polymers as well as general applications of their nanocomposites, significance of sustainable resource based nanocomposites and their applications in the field of corrosion. A major portion is also dedicated to VO based nanocomposites along with different

modifiers like clay nanoparticles, metal oxide nanoparticles and conducting polymer nanoparticles.

Chapter 2: Synthesis and characterization of ferrite (Fe_3O_4) nanoparticles

Chapter 2 describes the preparation of Fe_3O_4 nanoparticles using a modified polyol method. The synthesized Fe_3O_4 nanoparticles were characterized using ultra violet (UV), Fourier transform infra red (FTIR), X-ray diffraction (XRD), transmission electron microscopy (TEM), vibrating sample magnetometery (VSM) and thermalgravimetric analysis (TGA) techniques.

Chapter 3: Synthesis and characterization of TiO_2 and Ce doped TiO_2 nanoparticles

Chapter 3 deals with the preparation of TiO_2 and Ce doped TiO_2 nanoparticles using a modified polyol method. The size and structural characterization of these nanoparticles were performed with the help of UV, FT-IR, XRD, TEM, and SEM. These studies confirm the formation of TiO_2 nanoparticles of 15-20 nm size and Ce doped TiO_2 nanoparticles of 10-15 nm size.

Chapter 4: Synthesis, characterization and electrochemical corrosion resistance studies of soy alkyd/Fe_3O_4 nanocomposite coatings

This chapter discusses the formulation and characterization of soybean oil derived alkyd (organic matrix)-Fe_3O_4 (used as filler) based nanocomposite coatings, using butylated melamine formaldehyde (BMF) as curing agent. The nanocomposites were characterized by FT-IR, TGA, optical microscopy (OM), TEM and SEM. The nanocomposite coatings were subjected to physico-chemical and physico-mechanical characterization by standard methods. The corrosion protective performance of these coatings in NaCl solutions was evaluated using potentiodynamic polarization (PDP) studies and electrochemical impedance spectroscopic (EIS) measurements. The above mentioned electrochemical corrosion studies reveal that with increasing the loading of Fe_3O_4 nanoparticles in soy alkyd, the corrosion resistance performance of coating further increases.

Chapter 5: Synthesis, characterization and electrochemical corrosion resistance studies of TiO_2 and Ce-TiO_2 polyester-urethane (PEUTES) nanocomposite coatings

Chapter 5 reports TiO_2 and Ce doped TiO_2 dispersed soybean oil derived PEUTES nanocomposite coatings. The PEUTES was derived from soybean oil a renewable resource. Ce doped TiO_2 dispersed PEUTES coatings exhibit superior performance than those of undoped TiO_2 dispersed coatings. Studies in this chapter and literature survey revealed that TiO_2 and Ce-TiO_2 dispersed PEUTES coatings exhibited superior performance than those of other such reported systems.