Abstract

Fracture toughness and abrasion resistant are the most important characteristics of polyurethane rubber that candidate it as a coating for wind turbine blade. Polyurethane rubber is not strong enough, and reinforcement with microfiller adversely affects the toughness property. In this study, it had been proposed the carbon nanotubes reinforcement to enhance the mechanical properties of polyurethane rubber.

This work is divided into three parts: preparation and characterization of carbon nanotubes, functionalization and characterization of carbon nanotubes, and preparation and characterization of carbon nanotubes/polyurethane rubber nanocomposite.

Water assisted chemical vapor deposition was used to prepare carbon nanotubes. Different parameters such as substrates (alumina, silicon wafer, and quartz), catalyst type (nickel and iron oxide), catalyst size, carbon source (methane and acetylene), gases ratio, temperature and time were used. High resolution transmission electron microscope and energy dispersive X-ray spectroscopy were used to characterize catalysts. High resolution scanning electron microscope, transmission electron microscope, high resolution transmission electron microscope, Fourier transform infrared spectroscopy, X-ray diffraction and Raman spectroscopy were used to characterize carbon nanotubes.

Ultrasonication with covalent functionalization process by acids and non-covalent functionalization process by surfactants were used to disperse and functionalized carbon nanotubes. Transmission electron microscope and Fourier transform infrared were used to characterize the functionalized carbon nanotubes.

Single-walled beside plain multi-walled and twisted multi-walled carbon nanotubes, carbon nano fibers, and amorphous carbon were obtained during different experiments of water assisted chemical vapor deposition process.

Acetylene gas as carbon source yields more carbon nanotube than methane gas. Alumina substrate yields more carbon nanotube than silicon wafer and quartz. Nickel catalyst yields more carbon nanotube than iron catalyst.

It was found that water assisted chemical vapor deposition is efficient process to grow pure carbon nanotube.

Also the size of catalyst nanoparticles is very dependent on thin film thickness from which it was grown. The average diameters of carbon nanotube

decreased with the decreasing of the catalyst nanoparticles sizes from which they were grown.

Non-covalent functionalization of carbon nanotubes by surfactant is nondestructive approach compared with covalent base approaches.

A twisted carbon nanotube was selected to reinforce polyurethane rubber and it can be used as a coating for wind turbine blade application instead of pure polyurethane. Three different weight percent of carbon nanotube (0.3, 0.5 and 1 weight percent) with different functionalization (-COOH, Triton X-100 and BYK W-980) were used as parameters. Carbon nanotubes/polyurethane composites were prepared by *solution casting* and *in-situ polymerization process* methods. Tensile, fracture toughness, flexural, impact, erosion wear, abrasion wear and hardness tests were executed.

The results showed that mechanical properties of polyurethane rubber enhanced with the increase of carbon nanotube weight percent. Also Triton X-100 functionalized carbon nanotubes gives better mechanical properties of polyurethane rubber composites than BYK W-980 and covalent functionalized carbon nanotube. The optimal values of properties were for polyurethane rubber reinforced with Triton X-100 functionalized (1 weight percent) of carbon nanotube (except the flexural properties). The optimal values in the flexural properties were for polyurethane rubber reinforced BYK W-980 functionalized (1 weight percent) of twisted carbon nanotubes.

So the best supposed composite for wind turbine blade coating is Triton X-100 functionalized twisted structure carbon nanotubes reinforced polyurethane rubber.