Improved Mechanical Properties of Aluminium Powder-Carbon Nanotubes and Epoxy Nanocomposites to Fabricate Blades for Wind Turbines and Different Components of Machines and Equipment

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Introduction

Blades for wind turbines are critical parts in the manufacture, design and operation of wind turbine power plants, they have to support extreme weather conditions sometimes at the same day like snow, rain, 50 degrees below 0 and +45 degrees temperatures without suffer any deformation, bending, crystallization, fracture, wear, support hurricanes and strength winds, have to be light weight or low density, not to decrease the structural behavior during the rotation and transmission of mechanical power . The main manufactures of wind turbines have specific research centers to improve the materials, most of the materials are special composites and affect the design and operation of wind turbines.

In this study we have fabricated different combinations of aluminium powder, epoxy and carbon nano tubes to have a novel material with better structural properties, especially for small and medium size wind turbines in the Rank of 0.100 to 100 Kilowatts, for functionalization we modified the surface of aluminium powder and nanotubes with 3 aminopropyltriethoxysilane to have a bonding and adhesion with the epoxy and aluminium-nanotubes in the particulate Nano composite tensile, flexion, hardness test were performed in Universal testing machine and Vickers hardener tester, stress-strain curves of different combinations of particles and materials in the Nano composites and also compared with the standard materials utilized to fabricate the blades like, Nylon 6, carbon fiber, fiber glass are showed after the results of the different tests. Toughness, ductility, bending were studied to analyze which materials have better performance in some sizes and powers of wind turbines. Wind turbines blades were fabricated also to have a real test of the behavior of the materials on site. Cifuentes et al (1) studied and fabricated aluminium powder epoxy composites with silane surface modified aluminium powder to improve the mechanical properties, Rhee, Kathi, Lee et al (2) functionalized carbón nanotubes with 3 aminopropyltriethoxysilane, TPI industries et al (3) show the composites, materials and different steps to design, fabricate and tests for the blades of medium and big size wind turbines, up to 1 MW.

Fabrication and Analysis of Nano Composite

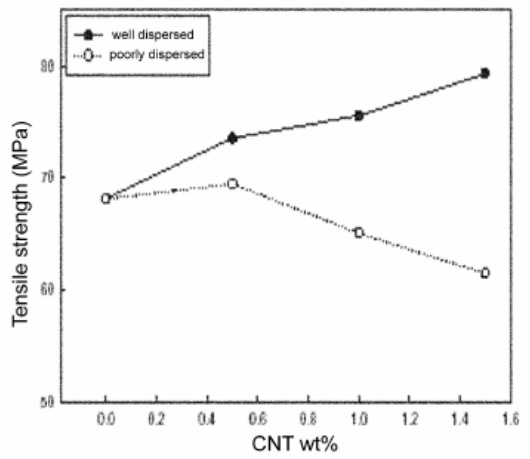
Before fabricate the Nano composites the aluminium powder and carbon nanotubes were functionalized by modifying of the surface with 3 aminopropyltriethoxysilane to have bonding and adhesion among the particulate materials in Nano composites with different percentages per weight 0.2, 0.5, 1, 1.2, 1.5, 2 % of nanotubes and 2, 5, 7, 8, 10 % of aluminium powder were fabricated by cast molding method. Tensile and flexion specimens were CNC machined, then tensile, flexion test were performed, stress-strain curves and toughness, stiffness calculation to compare and analyze the mechanical properties of the different Nano composites were studied. Fig. 1 show the composites and Nano composites fabricated, Fig. 2 show the specimens of the different fabricated materials. Fig 3 show the fracture mechanics mode I specimens before the tests.

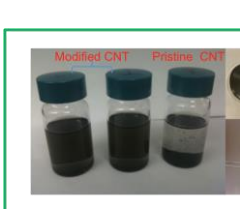
Tests Performed

Tensile, flexion and bending tests were realized in the Universal Testing Machine, Rockwell hardness test were realized in different points of the specimens and composites. Fracture mechanics mode 1 tests were performed in the Universal testing machine. Scratch, sand paper and grinding tests were realized to compare the roughness, surface hardness and consistence of the different materials fabricated.

Characterization

Samples were observed in the Metallurgical microscope on the fracture surface after the tests, SEM analysis was performed to see the dispersion of the aluminum powder, carbon Nano tubes and the bonding among the materials with the epoxy matrix., AFM was performed to analyze the dispersion and adhesion in the molecular and atomic scale.





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