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Nanoparticles for Improving the Interfacial Bonding Strength and Thermal Performances

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Introduction

Ceramics nano metric reinforced polymer composite is an important material for a variety of applications, including catalysis, solar cells, hydrogen production, and energy applications. This ceramic nanomaterial was synthesized using the sol-gel process in an effort to investigate the thermal stability, structure, and morphology of the resulting nanoparticle powders. This was done in order to take advantage of the intriguing mechanical properties and thermal stability of TiO_2. This work focused on the thermal characterization and investigation of the nano composite xWt% TiO_2/PP (x=0, 2.5, 5, 7.5 mol%). The obtained results demonstrated that the sphere is comprised of nanoparticles of 20-30 nm with excellent thermal stability of nano-TiO_2. The results of this study showed that the final thermal stability and crystallinity of the composite are affected by the TiO_2 molar ratio. The use of TiO_2 was found to be an efficient and very promising method for improving the thermal properties of the composite that was produced. Ceramics nano metric reinforced polymer composite is a significant material for catalysis, solar cells, hydrogen production, and energy applications, among other things. It has the highest degree of crystallinity (54.80%) and thermal degradation stability. This ceramic nanomaterial was synthesized using the sol-gel process in an effort to investigate the thermal stability, structure, and morphology of the resulting nanoparticle powders. This was done in order to take advantage of the intriguing mechanical properties and thermal stability of TiO_2. This work focused on the thermal characterization and investigation of the nano composite xWt% TiO_2 /PP (x=0, 2.5, 5, 7.5 mol%). The obtained results demonstrated that the sphere is comprised of nanoparticles of 20-30 nm with excellent thermal stability of nano-TiO_2. The results of this study showed that the final thermal stability and crystallinity of the composite are affected by the TiO_2 molar ratio. The use of TiO_2 was found to be an efficient and very promising method for improving the thermal properties of the composite that was produced [1]. The composite reinforced with 7.5 Wt% TiO_2 has the highest crystallinity (54.80%) and thermal degradation stability.

Description

Due to their improved specific properties, polymer composite materials are attractive for a variety of technological applications. Polymer materials' physical and thermal behavior is influenced by their degree of crystallinity and thermal degradation. One strategy for developing novel nanomaterials for a variety of uses is to establish a correlation between their mechanical and structural properties. The widespread use of composites in recent years has prompted the use of nanoparticles as reinforcement for enhancing thermal properties and interfacial bonding strength. Polypropylene has been used in a variety of applications due to its excellent chemical stability, according to a number of researchers. Due to its high stiffness, low processing temperature, and low density, it is utilized extensively in advanced technologies. In the present work, synthesis revealed the impact spherical anatase TiO_2 nanoparticles on the thermal performances of polypropylene resin DTA/TG, SEM, TEM and XRD analysis determined the thermal, structural and morphology behavior of the TiO nanoparticles. In this research study, details of Nano-composites synthesis were presented. MEB analysis revealed the nanoparticle dispersion in the Nano composites. Thermal degradation stability and degree of crystallinity were observed using DSC and TG/DTG [2].

The catalysts methanol and Acetic Acid (CH_3COOH) and the precursor Titanium Tetra Iso-Propoxide (TTIP) were mixed in the following order to create TiO_2 nano powder. To produce the TiO_2 sol, the mixture was continuously stirred for thirty minutes. After that, the sols were put into an autoclave where they were pressurized and heated to 243ºC in order to reach the critical point of ethanol (Tc=243ºC, Pc=63 bar). The sol gelated after an hour of keeping the temperature at 243ºC. Nitrogen gas was used to depressurize the interstitial solvent for an hour until it was at room temperature. The autoclave was opened after 24 hours to gradually reach thermal equilibrium in order to prevent the sample from cracking as a result of thermal strain. Finally, TiO_2 aerogels were produced and annealed for an hour in air at 500ºC. A For TiO_2 /PP Nano composite preparation, commercially available isotactic PP (density=0.9 $g.cm^{-3}$) was purchased from national industrialization company JSC (TASNEE). Then, nano composites were prepared with different nano-TiO_2 contents (wt%, 2.5 wt%, 5 wt% and 7.5% wt% TiO_2). To do so, TiO_2 nano powder was added to PP resin and dispersed by using a mixer (30 min at room temperature).

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Then, the different nano composites were prepared using a twin screws extruder MEG DS32-1A (screw diameter of 35/80 mm and T°=210°C) [3]. Then, the solidified nano composites were pelletized with crusher, and traction specimen were obtained by injection molding (SM-120 TSCE, T°=30°C) [4].

In order to study the structural properties and phase identification, TiO_2 nano powder was analyzed using PANalyticalX'Pert Pro MPD diffract meter with Cu Kα radiation (λ=1.5418 Å) for X-Ray Diffraction (XRD) measurements recorded in the 20°-85° 2θ range at room temperature with an incidence angle of 0.05. From XRD patterns, average crystal sizes were calculated using Scherrer's formula. The thermal stability of the nano-TiO_2 was studied by DTA and TG analysis. The DTA and TG analyzes were performed in an atmosphere from ntemperature to 800°C with a heating rate of 20°C/min. For the analysis, it was used approximately 10 mg of sample [5].

Conclusion

The hydrothermally assisted sol-gel method was used to synthesize nano-TiO_2 with spherical morphology and nanometric crystallite size in this study. The anatase TiO_2 phase can be seen in the diffraction peaks. The sphere is made up of nanoparticles of 20-30 nm, as shown by the TEM images. The purpose of this article was to discuss how the morphology and thermal properties of the polypropylene resin are affected by the nano-TiO_2 powders. With the addition of Nano TiO_2, the polypropylene's thermal degradation stability improved.

The incorporation of nano TiO_2 into the polypropylene matrix significantly increased the crystallinity, as demonstrated by the obtained results. As a result, the presence of anatase nano fillers in the polyester matrix increased the number of interfacial interactions.

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