Extended Abstract

Graphene 2018: Carbon nanotubes used as a thermal stabilizer in polymers-Yeong-Tarng Shieh-National University of Kaohsiung, Taiwan

Abstract

We began with the study of various surface-modified multiwalled carbon nanotubes (CNT) for a use as a radical scavenger. Electron spin resonance (ESR) and ultraviolet/visible spectrophotometer (UV/Vis) were used to measure radical scavenging efficiencies of the modified CNT for hydroxyl (OH.) radical and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical, respectively. ESR, UV/Vis, and Raman spectra revealed that all CNT samples were good radical scavengers for both radicals and the radical scavenging efficiencies increased with increasing contents of defect sites on the modified CNT. We also investigated the radical scavenging efficiencies of silane-grafted CNTs for OH and DPPH radicals and found that the radical scavenging efficiencies decreased upon increasing the degree of the silane grafting, due to the steric bulk of the silane grafts on the surfaces of the CNTs. We used DSC to examine the effects of the silane-grafted CNTs on the exothermic peaks of the free radical–initiated crosslinking reactions of vinyl ester/styrene resins. The silane-grafted CNTs were found to retard the crosslinking reactions to various extents: a higher degree of grafting resulting in a lower crosslinking retardation. Finally, we assessed the surface-modified CNT (CNT, bmCNT, and CNT-COOH) as thermal stabilizers in poly (vinyl chloride) (PVC). Films of pure PVC, CNT/PVC, bmCNT/PVC, and CNT-COOH/PVC cast from tetrahydrofuran were subjected to thermal aging in N2 in a test tube submerged in an oil bath maintained at 180°C for a certain time. FTIR and UV-Vis spectra and discoloration of aged PVC composites were investigated on the formation of conjugated polyene structure in PVC. The results found that all three types of CNT of small amounts (0.1 or 0.3 phr) could stabilize PVC against thermal degradation by resisting the formation of a conjugated polyene structure in the order of bmCNT > CNT > CNT-COOH. Moreover, Congo red test and pH measurement has been investigated on the dehydrochlorination of PVC during the thermal aging. The bmCNT was also the most productive thermal stabilizer among the three types of nanotubes studied to with stand degradation of HCl from PVC. This newly-developed PVC composite with CNT as an additive can deliver an efficient route in the direction of the development of highly thermal-stabilized PVC.

Scientists first described carbon nanotubes in the early 1990s. Since then, these tiny cylinders have been part of the quest to decrease the measurement of technological gadgets and their components. Carbon nanotubes (CNTs) have very ideal properties. They are one hundred instances more desirable than steel and one-sixth its weight. They have countless instances the electrical and thermal conductivity of copper. And they have almost none of the environmental or physical degradation troubles common to most metals, such as thermal-contraction and growth or erosion.

CNTs have a propensity to aggregate, forming "clumps" of tubes. To utilize their eminent properties in applications, they are required to be dispersed. But they are insoluble in many liquids, making their even distribution process difficult.

Scientists developed a method that "exfoliates" aggregated clumps of CNTs and disperses them in solvents. It includes wrapping the tubes in a polymer the use of a bond that does now not involve the sharing of electrons. The method is called non-covalent polymer wrapping. Whereas sharing electrons thru covalent polymer wrapping leads to a greater steady bond, it additionally modifications the intrinsic applicable homes of the carbon nanotubes. Non-covalent wrapping is hence viewed greatest in most cases because it causes minimal detriment to the tubes.

They determined that a vast range of polymers can be used for the non-covalent wrapping of carbon nanotubes. Recently, many polymer dispersants have certainly been developed that not only disperse the CNTs but also add new features to them. These polymer dispersants are now extensively diagnosed and utilized in many fields, which include biotechnology and strength applications.

CNTs that are stably wrapped with biocompatible substances are extremely attractive in biomedicine, for example, due to their incredible capacity to ignore organic limitations except generating an immune response. There is for that reason high attainable for polymer wrapped CNTs in the vicinity of drug delivery.

Also, wrapping carbon nanotubes in polymers improves their photovoltaic functions in photo voltaic cells, for example, when the polymers feature like a light-receiving pigment.

Because the designs of polymers can be easily tailored, it is predicted that the functionality of polymer wrapped CNTs will be similarly improved and that novel applications the use of them will be developed.

All nanotubes are predicted to be excellent thermal conductors along the tube axis, exhibiting a property regarded as ballistic conduction, however suitable insulators laterally to the tube axis . A SWCNT is displayed to have a thermal conductivity along its axis of about 3500 Wm^{-1} K^{-1} at room temperature. This price is nearly 10 instances higher than that of copper, a metal well recognized for its precise thermal conductivity which is 385 Wm^{-1} K^{-1}. A SWCNT has a room-temperature thermal conductivity in the radial path of about 1.52 W/m/K2 which fits very nicely with the thermal conductivity of soil. The temperature balance of CNTs is estimated to be up to 2800°C in vacuum and about 750°C in air.

Functionalization enhances the solubility and processability, and permits combining the special houses of nanotubes with these of different materials It additionally improves the interaction of the nanotube with other entities, such as a solvent, polymer and other natural molecules and also with other nanotubes. A functionalized nanotube displays exclusive mechanical and electrical properties as compared to pristine nanotube and for that reason may additionally be utilized for countless applications.

The outstanding properties of CNTs such as their high electricity and stiffness make them ideal candidates for structural applications. At present, polymer nanocomposite is one of the largest application areas for CNTs. The peculiar properties of CNTs coupled with effortlessly tailorable traits of polymers provide upward push to versatile CNT-polymer nanocomposites. The emergence of CNTs as filler materials has contributed to the recognition of CNT-polymer nanocomposites as subsequent generation superior structural material. However, the invention of CNTs added an additional boost in the polymer nanocomposite research promising potential for various applications.

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