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Effect of an encapsulate carbon nanotubes (CNTs) on structural and electrical properties of PU/PVC nanocomposites

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ABSTRACT

Nanocomposites samples of polyurethane and polyvinyl chloride (PU/PVC) loaded both multi and single walled-carbon nanotubes were synthesized by the casting technique. The X-ray analysis indicated that decrease degree of crystallinity after addition of carbon nanotubes (CNTs) due to interaction between CNTs and PU/PVC. The Transmission electron microscope (TEM) indicated encapsulation of polymer blend on CNTs surface. The highest value of AC conductivity was observed at high content of CNTs and frequency related effective conductive network formed when CNTs loaded in the blend. Whereas molecules of CNTs bridged between localized states and potential barrier. The permittivity (ε') was decreased when the frequency increased due to direction dipoles of applied electric field. At high frequencies, the decreasing trend of permittivity seems nearly stable attributed to dipoles orientation. The higher value of dielectric loss (ε'') was observed at low frequency due to the mobile charges within blend backbone. An increases of loss tangent (tan δ) with increasing in CNTs content was expected because conductivity increases with increasing CNTs. The decrease of tan δ with increasing frequency is attributed to the fact that the hopping frequency of charge carriers cannot follow any changes of externally applied electric field.

1. Introduction

Carbon nanotubes (CNTs) have been discovery by Iijima in 1991 [1], they've many possibility applications such photovoltaic, nanoelectronic devices [2], electromechanical actuators [3], superconductors [4], nanowires [5], nanocomposite materials [6], and electrochemical capacitors [7]. Carbon nanotubes (CNTs) are hollow cylinders atoms of carbon and occurrence rolled tubes of graphite, so its walls are hexagonal rings of carbon, and formed in large bundles. The Carbon nanotubes ends are capped by a 5-membered ring, domed structures of 6-membered rings. There's two forms of nanotubes: multi-walled nanotubes (MWNTs) and single-walled nanotubes (SWNTs), which differ in the arranging cylinders of graphene. single-walled nanotubes have one single layer cylinders of graphene; while multi-walled nanotubes have several layers around 50 [8]. Other approaches have been suggest for homogeneous dispersion of CNTs in polymer matrix, such as direct suspension of CNTs in polymer solution in situ

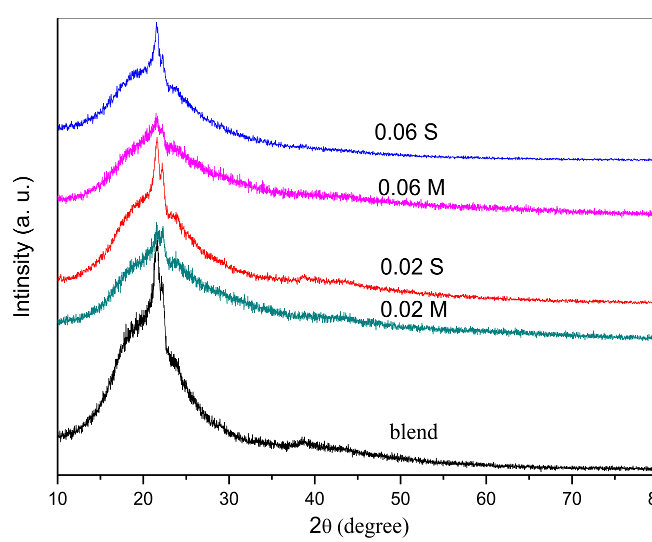

Fig. 1. X-ray diffraction of PU/PVC with different concentrations of MWCNT and SWCNT.

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polymerization in the presence of CNTs [9], surfactant-assisted processing [10] and via sonication of CNT-polymer composites [11,12]. Attracted attention of CNTs as a conductive filler in insulating polymer matrix because have thermal conductivity, excellent mechanical strength, and high electrical. CNTs have been utilized as conductive fillers in polymer matrices. It was observed each of the maximum conductivity and the percolation threshold show to depends on the properties of conducting fillers, conducting filler dispersion in polymeric matrices, the interaction between filler and polymer matrices and alignment of CNTs within polymer matrices [13–15]. A polymer/CNTs nanodielectric has multifunctional properties because of interactions of CNTs with polymer matrices and intensely large interface space. Thus, alignment of CNTs within polymer matrices has a predominating role about the properties of electrical to polymer/CNTs nanodielectric. The principle challenges in nanodielectrics material are to alignment of CNTs and improve the dispersion in polymer matrices. Recently, Thostenson et al. studied CNTs and their nanocomposite materials [16]. The addition of carbon nanotubes in composites is expected electrical properties is improve, because of the distinguished electrical properties of carbon nanotubes. CNTs are not only high efficiency conductors of electricity and heat [17], but have electrical conductivity is one thousand times higher than that wires of copper. Thus, the electrical conductivity of CNTs will effect of insulating polymers from through its energy gap [18]. Banda et al. prepared single-walled carbon nanotube with polymers to improvement mechanical and electrical properties of polymers [19]. Hezma et al. [20] has been added polyurethane to Polyvinyl chloride to get better property and compatibility of structural and thermal from different blends and selected (75/25 wt%) of PU/PVC as best blend. This paper study effects of SWCNT-COOH and MWNT–COOH on the structural, and electrical properties of nanocomposites were investigate. The future interest is related to possible application of these nanocomposites where a

Table 1
Degree of crystallinity for PU/PVC with different content of CNTs.

(PU/PVC) CNTs (wt%)	Crystallinity (%) with SWCNTs	Crystallinity (%) with MWCNTs
0.00	55	55
0.01	48	45
0.02	35	30
0.04	30	25
0.06	25	20

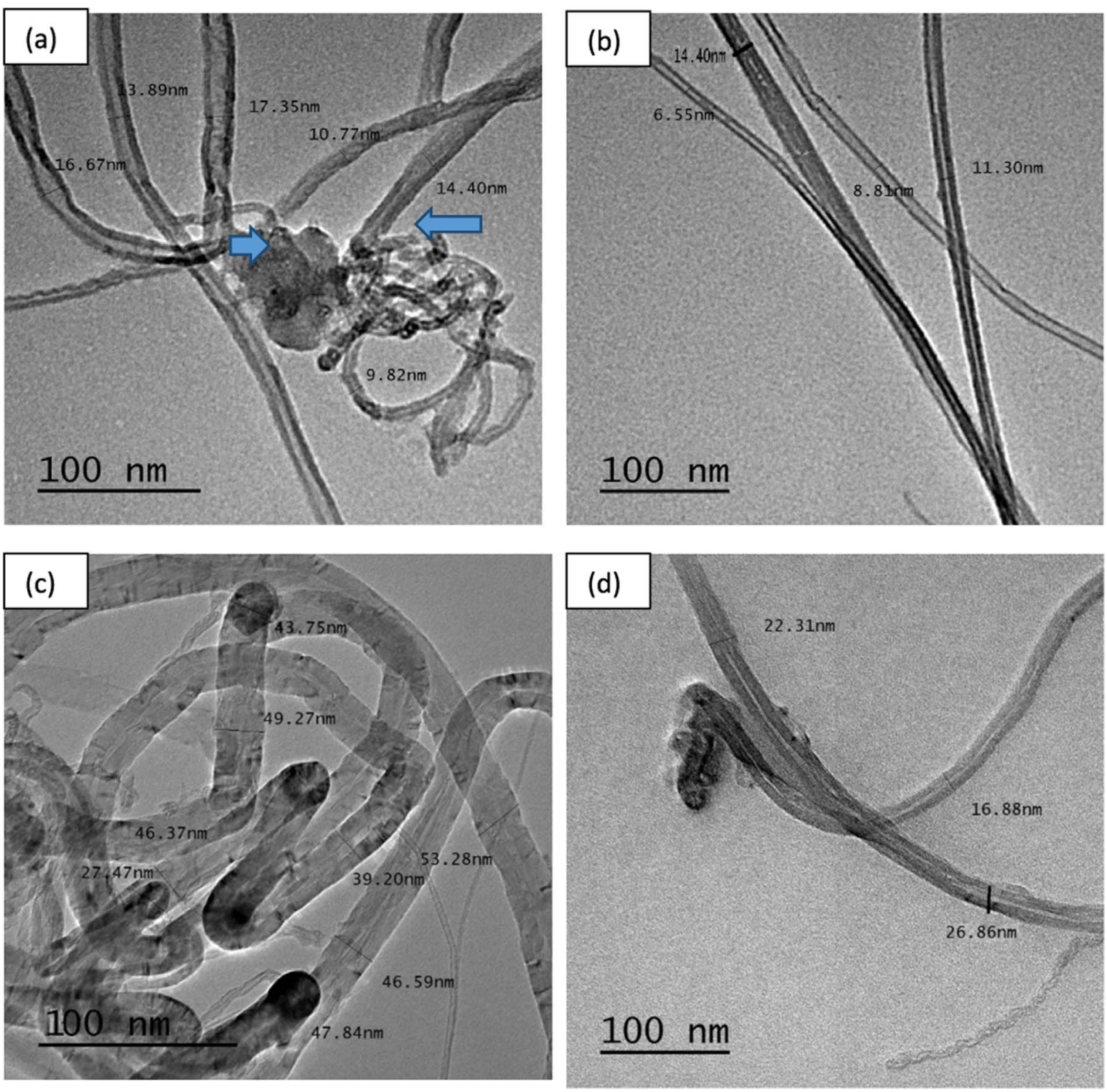

Fig. 2. TEM micrographs for: (a) pure MWCNTs, (b) pure SWCNTs, (c) (PU/PVC)-MWCNTs and (d) (PU/PVC)-SWCNTs at 0.06 wt% concentration.