

Accepted Manuscript

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PII: S0032-3861(16)30846-1

DOI: [10.1016/j.polymer.2016.09.047](https://doi.org/10.1016/j.polymer.2016.09.047)

Reference: JPOL 19053

To appear in: *Polymer*

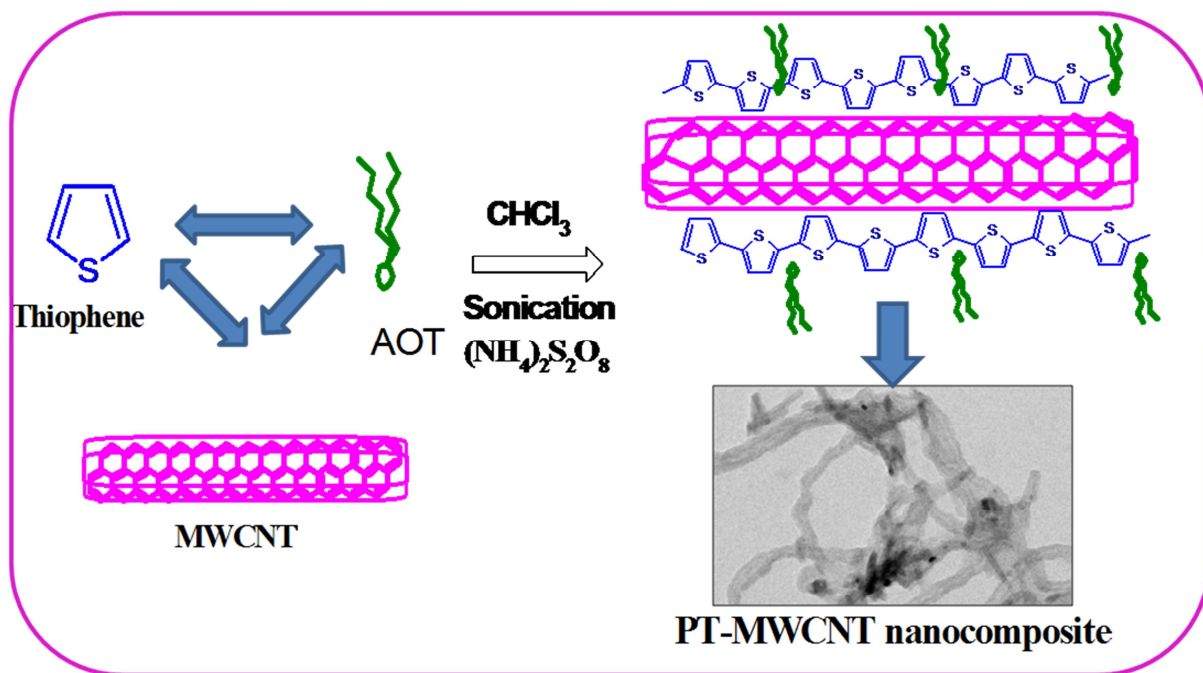
Received Date: 8 June 2016

Revised Date: 10 September 2016

Accepted Date: 16 September 2016

Please cite this article as: Swathy TS, Jose MA, Antony MJ, AOT assisted preparation of ordered, conducting and dispersible core-shell nanostructured polythiophene - MWCNT nanocomposites, *Polymer* (2016), doi: 10.1016/j.polymer.2016.09.047.

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Revised manuscript submitted to*polymer*

AOT Assisted Preparation of Ordered, Conducting and Dispersible Core-Shell Nanostructured Polythiophene - MWCNT Nanocomposites

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ABSTRACT

Core-shell nano structured polythiophene-multiwalled carbon nanotube nanocomposites (PT-CNTs) have been synthesised by in-situ chemical oxidative polymerisation of thiophene in presence of multiwalled carbon nanotubes (MWCNT) and anionic surfactant sodium bis(2-ethylhexyl) sulfosuccinate (AOT) using ferric chloride as an oxidising agent in chloroform solution. Nanocomposites were prepared by introducing different weight percentage amount of MWCNT into a fixed monomer and surfactant composition. The formations of the polythiophene-multiwalled carbon nanotube nanocomposites have been characterised by fourier transform infrared spectroscopy and elemental analysis. Sodium bis(2-ethylhexyl) sulfosuccinate (AOT) has been used as dopant cum template for polythiophene and polythiophene- multiwalled nanocomposite preparation. WXRd studies reveal that polythiophene has shown a broad peak at 2θ value 18.23° . On the other hand, PTCNT nanocomposites were shown a sharp peak at 2θ value 26.48° and the broad peak present in polythiophene was completely vanished upon nanocomposite formation. The scanning electron microscopic (SEM) analysis of the samples reveals that PTCNT nanocomposites have a fiber like nanostructures. The core-shell nanostructure formation was confirmed by transmission electron microscopy (TEM) analysis. The outer shell thickness of the carbon nanotubes in nanocomposite increases approximately 3 nm to 15 nm from the original thickness after the formation of nanocomposite. The PTCNT samples synthesised in presence of AOT were easily dispersed in chloroform, which enabled us to carry out the UV-Visible absorption spectroscopy. The characteristic absorption peak present at 340 nm corresponds to the π - polaron transition of polythiophene. The formation mechanism of core-shell nano structured composites was proposed based on the evidence from SEM, TEM, WXRd and spectroscopic studies. The four probe electrical conductivities of PTCNT samples were of the order of 1.5 times higher in magnitude than PT samples.

Key words: Nanocomposites, core-shell nanomaterials, polythiophene-MWCNT, electrical conductivity, nano dispersions

INTRODUCTION

Conducting polymer nano-composite materials find numerous applications in many fields such as conducting and semiconducting electrical circuits and displays to power devices, microelectromechanical systems (MEMS), super capacitors, solar cell sensors and so on [1-10]. The nano sizes of the nanocomposite materials drastically influence optical, electrical and mechanical properties and such nanocomposites shows better properties than a bulk composite system [11-14]. Generally, nanocomposite materials have an added advantage of the induced or modified properties of the both components involved in it [11-17]. Conducting polymers such as polyaniline, polypyrrole, polythiophene, polyphenylenevinylene and their derivatives were reported as conducting polymers suitable for conducting polymer nanocomposite preparation [18-19]. Polythiophene (PT) and their derivatives have attracted a great deal of attention because of their unique properties such as redox properties, electrical properties, optical properties, thermal and environmental stability and so on [18-23]. Recently, carbon nanotubes (CNTs) have attained considerable importance in research and recognised as a promising material for different applications such as chemical sensors, hydrogen energy storage, field emission materials, catalyst support, nano electronic devices and so on [24-30]. Huge aspect ratio and the weak non covalent forces present throughout the carbon nanotubes enable them to aggregate in bundle, which makes it difficult for producing stable nanodispersion. The efforts to create nanocomposites of MWCNT with conducting polymers (CPs) have received great attention due to the promising type of applications and rectification of some individual limitations of the components [1-2].

Nano-dispersion of carbon nanotubes can be produced by sonication of (i) carbon nanotubes in presence of suitable dispersion stabilising agent or block copolymers (ii) surface functionalized carbon nanotubes and (iii) polymer-carbon nanotube nanocomposites [31-39]. Polymer-carbon nanotube composites can be prepared easily without any tedious synthetic

procedure and inexpensive in comparison with other methods. The two common methods for polymer-nanocomposite preparation are the *in situ* polymerization of monomers in the presence of carbon nanotubes or by direct mixing of CNT with polymer (post polymerisation mixing) are [13, 37-38]. Conjugated polymers were known to disperse carbon nanotubes very efficiently in organic solvents with the help of sonication. Literature reports reveal that conjugated polymers like polythiophene, polybenzimidazole, poly-phenylenevinylenes and polyimide can react with CNTs through the non-covalent supramolecular π -stacking interaction by wrapping polymer chain or by non helical adsorption [31]. Zhai et al have extensively functionalised the CNTs using conjugated block copolymers containing non conjugated blocks with tunable functionality [35]. Lin and co-workers made studies on conducting polymers and reported that polymers which are structurally close to the CNT matrix were good candidates for functionalization of CNTs [39].

In the present work, we have synthesised polythiophene-MWCNT nano composite by an in-situ polymerisation of the thiophene monomer in presence of MWCNT using AOT as anionic surfactant, ferric chloride (FeCl_3) as oxidant and chloroform as solvent. Bis (2-ethylhexyl) sodium sulfosuccinate (AOT) has been utilized as anionic surfactant which can stabilise both thiophene monomer and MWCNTs through non-covalent interaction. Nanocomposite formation was confirmed by spectroscopic analysis, elemental analysis and powder X- ray diffraction methods. Core shell nanostructured morphology of the nanocomposites were analysed by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Dispersibility of nanocomposites were checked in water and chloroform. Stable dispersions were produced in chloroform and therefore we were able to study the UV-Visible absorption studies the nanocomposite in chloroform solvent. In the present study, we have demonstrated a facile and easy method for producing core-shell nano

structured conducting polythiophene-MWCNT nanocomposites with good solid state ordering, conductivity, dispersibility and thermal stability.

EXPERIMENTAL

Materials and reagents used: Thiophene, sodium bis (2-ethylhexyl) sulfosuccinate (AOT), ferric chloride and multiwalled carbon nanotubes (MWCNT) were purchased from Sigma Aldrich. Chloroform, deionised water and acetone were purchased from Merck chemicals India.

Measurements and instruments: FT-IR spectra of the samples were recorded by Shimadzu FT-IR spectrometer using KBr pellet method. UV-Visible spectra of the samples were recorded by Shimadzu UV-Visible spectrometer in the range 200-800 nm with HPLC grade chloroform. The elemental analysis (CHNS) of the samples was recorded by elementar vario EL III element analyser. Powder wide angle X-ray diffraction of the samples were measured using Anton Paar, TTK 450 diffractometer by scanning the 2θ values ranging from 3-80 degrees. Scanning electron microscopic images of the samples were recorded by JOEL Model JSM - 6390LV scanning electron microscope. The transmission electron microscopic analysis was carried out by JOEL/JEM 2100 instrument having capacity of 200 KV and with magnification 2000X - 1500000X. Thermogravimetric analysis (TGA) of the sample is measured in Perkin Elmer, Diamond TG/DTA.

GENERAL PROCEDURE

Synthesis of PTCNT-100

Thiophene monomer (1ml, 12.50 mmol) and AOT [0.22 g, 0.50 mmol] was dissolved in chloroform (20 mL) and sonicated for 5 minutes. To the monomer-AOT mixture, MWCNT (0.10g) was added and sonicated for 10 minutes. Ferric chloride (2.43 g, 15.00 mmol) dispersed in 10 ml chloroform was added drop by drop to monomer-surfactant-

MWCNT mixture and sonicated for 15 minutes. After that it was stirred using a magnetic stirrer for 3 hours. The resultant polymer-nano composite was filtered and washed using water and then with acetone. The composite obtained was dried in vacuum oven at 60°C. Yield = 0.82 g. FT-IR (KBr, cm^{-1}) 1667, 1536, 1028 (w), 779 (w), 668. Elemental analysis (anal., wt %): C, 41.14; S, 17.80; H, 3.02.

The nanocomposite like PTCNT-200, PTCNT-300 and PTCNT-400 were prepared similarly by changing the weight of MWCNT as 0.20, 0.30 and 0.40 g respectively (see supporting information). The synthesis of PTCNT-300 without the addition of AOT is also shown in supporting information.

Synthesis of PT-25 (Monomer: surfactant ratio [1:1/25])

Thiophene monomer (1ml, 12.50 mmol) and AOT [0.22 g, 0.50 mmol] was dissolved in chloroform (20 mL) and sonicated for 5 minutes. To the monomer-AOT mixture, ferric chloride (2.43 g, 15.00 mmol) dispersed in 10 ml chloroform was added drop by drop to monomer-surfactant mixture followed by sonication for 15 minutes. After that it was stirred using a magnetic stirrer for 3 hours. The resultant polymer was filtered and washed using water and then with acetone. The polymer was dried in vacuum oven at 60°C. Yield = 0.58g. FT-IR (KBr, cm^{-1}) 1650, 1521, 1315, 1207, 1114, 1026, 778 and 691. Elemental analysis (anal., wt %): C, 53.73; S, 31.21; H, 3.74.

RESULTS AND DISCUSSION

Polythiophene-multiwalled carbon nanotube (PT-MWCNT) nanocomposites were prepared by *in situ* chemical oxidative polymerization of thiophene monomer in presence of multiwalled carbon nanotube (MWCNTs) and sodium bis (2-ethylhexyl) sulfosuccinate (AOT). Thiophene- AOT- MWCNT dispersion was taken in chloroform solution and polymerization was carried out using ferric chloride. The polar head and double tail structure of AOT helps to form normal micelles in aqueous and reverse micelles in non-aqueous solvents [40-42]. AOT micelles effectively stabilize the thiophene + MWCNT mixture due to unique head to double tail molecular structure (AOT possess more hydrophobic nature). A scheme for the synthesis of polythiophene and polythiophene-MWCNT nanocomposite via oxidative polymerisation is shown in figure 1. For typical polythiophene-MWCNT nanocomposite preparation, thiophene monomer was added to AOT solution in 20 ml chloroform followed by sonication for 5 minutes. MWCNT (0.10 g) was added to monomer-surfactant complex and sonicated for 10 minutes. Ferric chloride dispersed in chloroform was added to the polymerization mixture under sonication for 15 minutes and followed by magnetic stirring for 3h. Sonication of the reaction mixture provides stabilization of monomer-surfactant-MWCNT complex in solution and effective polymerization at the initial stage (see supporting information). The resultant brown colored polymer was filtered and washed using water and then with acetone. The polymer powder was dried in vacuum oven at 60°C. Similarly PTCNT-200, PTCNT-300 and PTCNT-400 were prepared by varying the amount of multiwalled carbon nanotube taken as 0.20, 0.30 and 0.40 g respectively. A similar procedure was adopted for preparation of polythiophene sample (PT-25) using the same monomer-surfactant ratio (1: 1/25) and same oxidizing agent concentration without the addition of MWCNT. The remaining procedure for purification and drying process were similar to that of PTCNT-100.

The polythiophene-carbon nanotube nanocomposite materials were subjected to FT-IR spectra by making thin pellet with KBr to confirm the formation of nanocomposites (see figure 2). The FT-IR spectrum of the PT sample was shown peaks at 1658, 1526, 1326, 1112, 1025, 787 and 688 cm^{-1} respectively. The strong peaks at 1526 cm^{-1} and 1658 cm^{-1} represent symmetric and asymmetric ring stretching contribution from the thiophene rings in polythiophene. Ring breathing vibrations form a weak peak at 1326 cm^{-1} . The peaks present at 1112 and 1025 cm^{-1} were due to the C-H in plane deformations. The peaks present at 787 and 688 cm^{-1} (medium) were indicates the C-S stretching mode and C-H out of plane deformation mode of thiophene unit [43-47]. Interestingly, the nanocomposites (PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400) have not shown any new peaks other than peaks present in polythiophene. However, the characteristic ring stretching contribution from polythiophene-MWCNT nanocomposite was much more intense than the polythiophene sample alone. This contribution can be attributed to the π stacked ring stretching of polythiophene and sp^2 hybridized aromatic ring stretching of the multiwalled carbon nanotubes, which causes the enhancement in the intensity peaks (See supporting information for FT-IR spectra of MWCNT). Elemental analysis data of PTCNT nano composites and PT-25 reveals that the overall weight percentage composition of sulphur is highest in polymeric state and which is decrease with increase in addition of carbon nanotube to the polymer (see table 1). Both the FT-IR and elemental analysis data supports the formation of polythiophene-MWCNT nanocomposite formation.

The solid state ordering of the samples were analyzed by powder X-ray diffraction methods (see figure 3). PT-25 has shown a characteristic broad peak at 2θ values ranging between 12° to 25° with its maximum is centered at 18.12° . This peak arises mainly due to the typical diffraction from the amorphous domains of the polythiophene chains. Interestingly, the nanocomposites like PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-

400 have shown only a sharp peak at 2θ value 26.48° . The peak appeared at 2θ value 26.48° was similar to the diffraction of (002) plane of MWCNT [48-49]. The absence of broad peak which appeared in PT-25 indicates that the loss of amorphous region of the polythiophene via nanocomposite formation with MWCNT. Therefore, aromatic rings of carbon nanotubes and polythiophene would have undergone good solid state ordering via π - π packing at a shorter inter planar distance ($2\theta=26$). WXR analysis of the polythiophene-MWCNT nanocomposite provides evidence for the π - π supramolecular interaction between polythiophene and MWCNT.

The polythiophene-MWCNT nanocomposites were subjected to scanning electron microscopy (SEM) to study the morphological features of the nanomaterials (see figure 4). The morphology of PT has nearly spherical in shape, whereas the polythiophene-MWCNT composite like PTCNT-100 and PTCNT-300 have fiber like nanostructure [37-38]. Multiwalled carbon nanotubes (MWCNT) have shown a typical nano fibrous morphology. The fiber like morphology of nanocomposite materials could be attributed to the template effect of the carbon nanotube on the growing chain of polythiophene. The transmission electron studies (TEM) studies were carried out to understand the interior features of the nanocomposite. TEM images of MWCNT, PTCNT-100, PTCNT-300 and PTCNT-300 without AOT were shown in figure 5. The multiwalled carbon nanotubes were shown tube like features which was evident from thick outer solid part of nanotube and unfilled area of inner tubes [37-38]. The thickness calculation of MWCNT reveals that nanotubes possess outer diameter of 12 nm and 5 nm inner tube diameter respectively. Interestingly, the polythiophene-MWCNT nanocomposite materials were shown definite increase in outer shell thickness from 3 to 15. TEM analysis of control sample PTCNT-300 without the addition of AOT (PTCNT-300AOT-0) reveals that the MWCNT and PT were phase separated, which suggests that AOT plays crucial role in core shell nanostructure formation.

The four probe electrical conductivity of the samples was measured by Keithleys four probe conductivity meter by measuring the average resistance at four different points. The conductivity of the PTCNT nanocomposites and PT-25 were shown in figure 6. The conductivity of the polymer samples PT-25, PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400 were 7.3×10^{-3} , 3.58×10^{-1} , 3.98×10^{-1} , 2.2×10^{-2} and 3.40×10^{-1} S/cm respectively [36-37, 50]. The conductivity of polythiophene-carbon nanocomposites were 1.5 order higher in magnitude than polythiophene. The increase in conductivity of the samples could be attributed to the conducting nature of both components of the composite and better charge transport through PTCNT nanocomposite.

The formation mechanism PTCNT nanocomposites were proposed based on the evidences obtained from the x-ray diffraction, morphological studies and FT-IR analysis (see figure 7). Polymerization of thiophene in presence of sodium bis (2-ethylhexyl) sulfosuccinate results in the formation of polythiophene sub microspheres. This could be attributed to the formation of AOT–thiophene spherical micellar aggregates and subsequent oxidative polymerization of these aggregates to produce sub microspheres. Although, reverse micelles formation of AOT in chloroform has been reported, addition of thiophene monomer triggers the aggregated micelle formation of AOT. In the case of PTCNT nanocomposite preparation, multiwalled CNT was added to the thiophene-AOT micellar complex with help of sonication. The thiophene-AOT aggregated micelles percolate towards outer walls of the multiwalled CNT and get stabilized to the walls of through non covalent interaction. Subsequent polymerization of stabilized monomer-AOT-MWCNT leads to the formation of core shell nanostructure, where the MWCNT part act as the structural framework for core and polythiophene makes the outer part of the shell.

Generally carbon nanotubes undergo aggregation due to weak non-covalent forces operating in them because of the lengthier dimension of the carbon nanotube and therefore it

is difficult to produce as stable dispersion. One attractive way to make stable dispersion is to make suitable polymer composite with CNT which have a structure similarity with CNT and easy to disperse. Dispersibility of polythiophene–MWCNT nanocomposites were checked in chloroform and water by sonication (see figure 8). All the PTCNT nanocomposite samples were shown stable dispersion in chloroform. The self aggregating forces of CNT were replaced by weak non-covalent forces between PT and CNT. In aqueous media, nanocomposite forms less stable dispersion due to the hydrophobic effect of the nanocomposites (see supporting information).

The good dispersibility of the nanocomposite in chloroform enabled us to record the UV-visible absorption spectra of nanocomposite materials. The UV-Visible spectra of the PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400 were recorded in chloroform were shown in figure 9. All the PTCNT samples have shown a characteristic peaks at 340 nm, which corresponds to the π - polaron transition observed in polythiophene [51, 52]. UV absorption was visible for still lower wavelength (<275 nm), however the nanocomposite peak from CNT was merged with the solvent UV cut-off wavelength of chloroform (240 and 260 nm) [53, 54]. Poor dispersion of MWCNT and PT-25 in chloroform hampers our effort to record the UV-Visible absorption (see supporting information). However, the dispersibility of the MWCNT alone in chloroform was improved with addition of AOT.

The thermal stability of the polymer-nanocomposite samples were recorded by thermogravimetric analysis at a heating rate of 5° per minute under nitrogen atmosphere. All the samples (PT-25, PTCNT-100 and PTCNT-300) have shown 10 % weight loss around 250-280°C [43]. Mass loss of polymer samples has reached 50-60 % at higher temperature like 500-600°C due to the decomposition of carbon from polymer chain. The thermal stability

of the polythiophene-MWCNT nanocomposite (PTCNT-100 and PTCNT-300) was found to have higher thermal degradation stability than PT-25.

CONCLUSIONS

Polythiophene-multiwalled carbon nanotube nanocomposites (PT-CNTs) were prepared by in-situ chemical oxidative polymerisation of thiophene in presence of multiwalled carbon nanotube using ferric chloride as oxidizing agent and sodium bis (2-ethylhexyl) sulfosuccinate (AOT) as anionic surfactant in chloroform solvent. Before the synthesis of the polythiophene-MWCNT nanocomposite, polythiophene (PT-25) was prepared to analyze the characteristic features of polythiophene. The following are the important outcome of the present work i) The formation of the PT and PTNCTs were confirmed by fourier transform infrared spectroscopy and elemental analysis ii) PTCNT samples exhibited the characteristic peak of carbon nanotube at 26.48° corresponding to (002) diffraction from MWCNT. iii) The amorphous domain of the polymer peak was completely vanished in nanocomposite due to the supramolecular interactions between MWCNT and polythiophene chains. iv) AOT plays a significant dual role as dopant and act as template for polythiophene and polythiophene- multiwalled nanocomposite formation v) SEM images of the PTCNTs reveal that nanofiber morphology of PTCNT composites was similar to MWCNT. vi) The TEM images clearly indicated the formation of core shell nano-structured tubes with shell of the composite being more thicker and core being hollow. vii) The good dispersibility of the PTCNT samples in chloroform allowed us to record the UV-Visible absorption spectra of the samples. viii) The nanocomposite have shown π - polaron transition at 340 nm ix) The formation mechanism of core-shell nanostructure composite was proposed based on the morphological studies x) The PTCNTs were shown good electrical conductivity, which was better than polymer due to good electrical transport in

nanocomposite. xi) Electrical conductivities of the PTCNTs samples were of the order of approximately 1.5 times higher in magnitude than the PT-25 samples. Thus in nut shell, we were able to synthesis polythiophene-MWCNT core-shell nanostructured composite via simple one step oxidative polymerization of thiophene in presence of MWCNT using AOT as anionic surfactant and ferric chloride as oxidant in chloroform

ACKNOWLEDGEMENT

We acknowledge UGC-India for research project MRP(S)-210/12-13/KLCA033/UGCSWRO and 1582-MRP/14-15/KLCA019/UGC-SWRO. We would also acknowledge DST for FIST programme implemented in St. Thomas College (autonomous), Thrissur. We also acknowledge STIC, Cochin for instrumental facilities availed such as elemental analysis, scanning electron microscopy, transmission electron microscopy, powder x-ray diffraction and thermo gravimetric analysis. JAM gratefully acknowledges his doctoral mentor Dr. M Jayakannan, Associate professor IISER, Pune for guidance and support.

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Figure Captions:

Figure 1. *In situ* synthesis of polythiophene-MWCNT nanocomposites.

Figure 2. FT-IR spectra of PT-25, PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400.

Figure 3. WXR D of PT-25, PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400.

Figure 4. Scanning electron microscopy images of the PT-25, MWCNT, PTCNT-100 and PTCNT-300.

Figure 5. Transmission electron microscopy images of MWCNT, PTCNT-300AOT-0, PTCNT-100 and PTCNT-300.

Figure 6. Four Probe electrical conductivity of PT-25, PTCNT-100, PTCNT-200, and PTCNT-400.

Figure 7. Formation mechanism of the core-shell nano structured of polythiophene-MWCNT nanocomposite

Figure 8. Dispersion of polythiophene-MWCNT in chloroform.

Figure 9. UV-visible absorption spectra of PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400.

Figure 10. TGA studies of PT-25, PTCNT100, and PTCNT-300.

Table 1: Thiophene and AOT amount in millimoles, weight of MWCNT, sulfur content in weight percentage, yield of the products.

Sample	Thiophene (mmoles)	AOT (mmoles)	MWCNT (g)	Elemental sulfur (%)	Yield (g)
PT-25	12.5	0.50	-	31.21	0.58
PTCNT-100	12.5	0.50	0.10	17.80	0.82
PTCNT-200	12.5	0.50	0.20	18.01	1.12
PTCNT-300	12.5	0.50	0.30	18.60	1.16
PTCNT-400	12.5	0.50	0.40	18.82	1.22

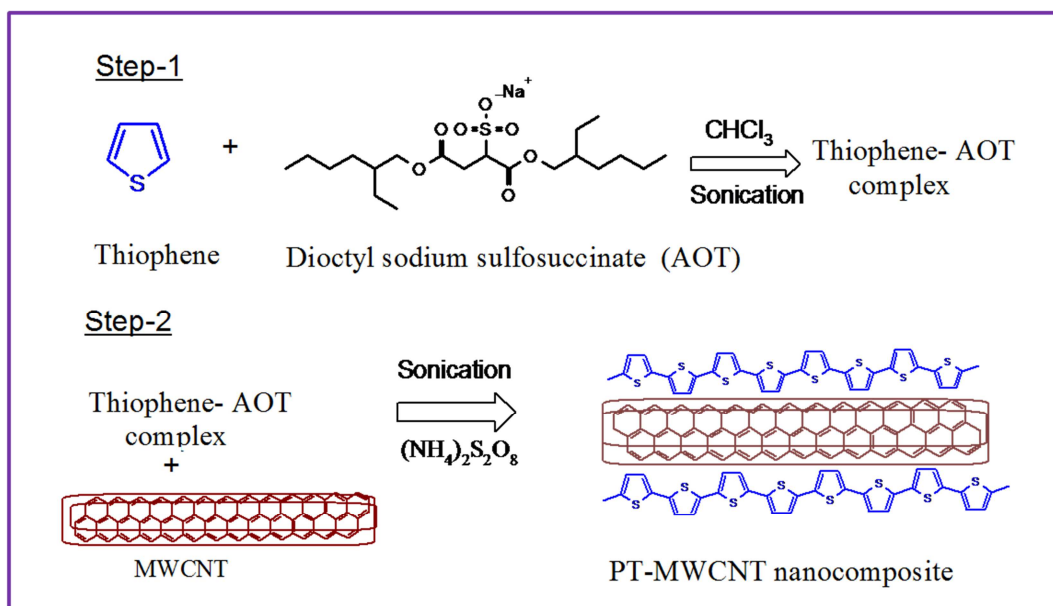


Figure 1. *In situ* synthesis of polythiophene-MWCNT nanocomposites.

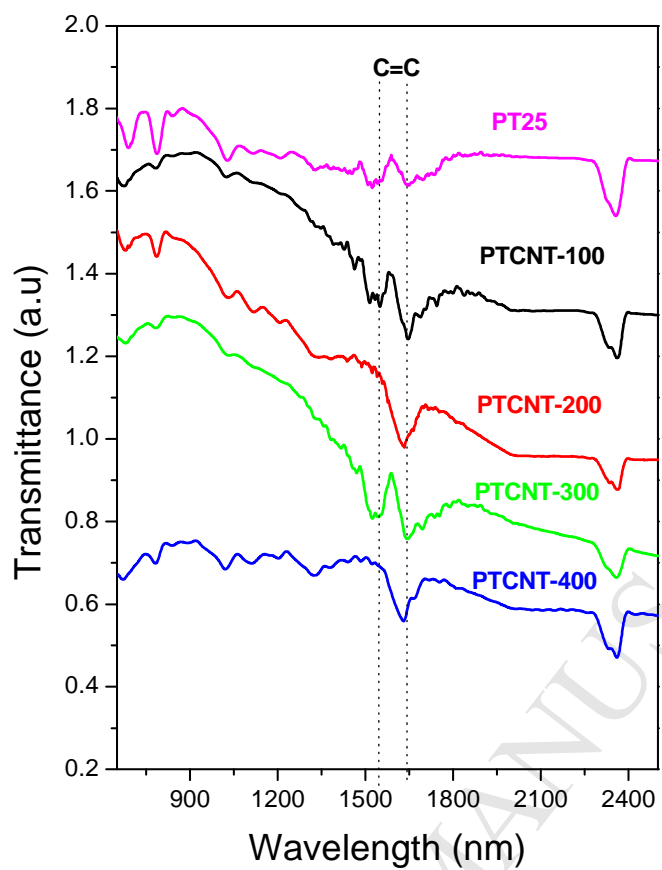


Figure 2. FT-IR spectra of PT-25, PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400

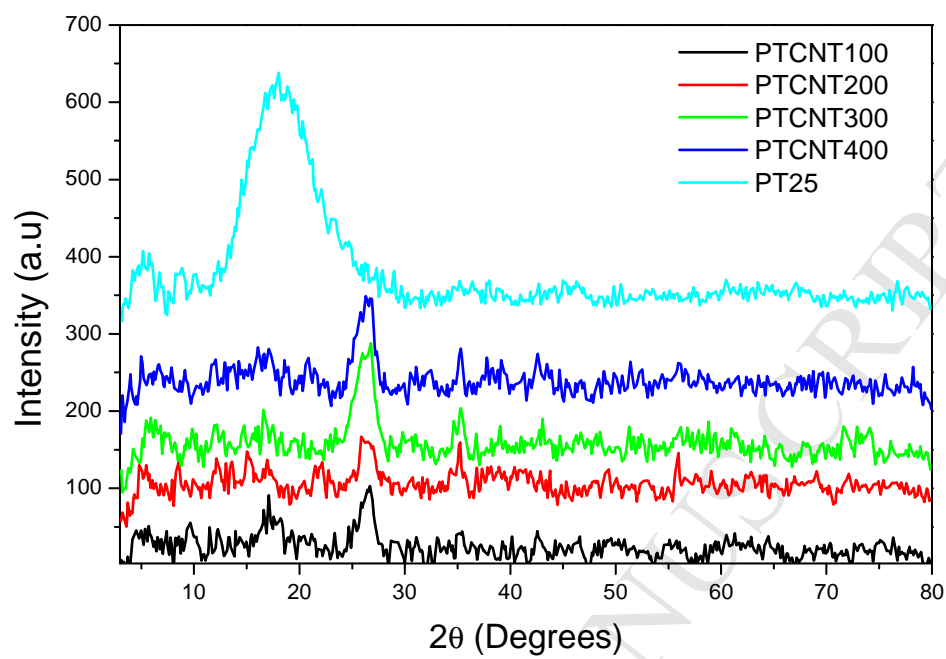


Figure 3. WXR D of PT-25, PTCNT-100, PTCNT-200, PTCNT-300 and PTCNT-400

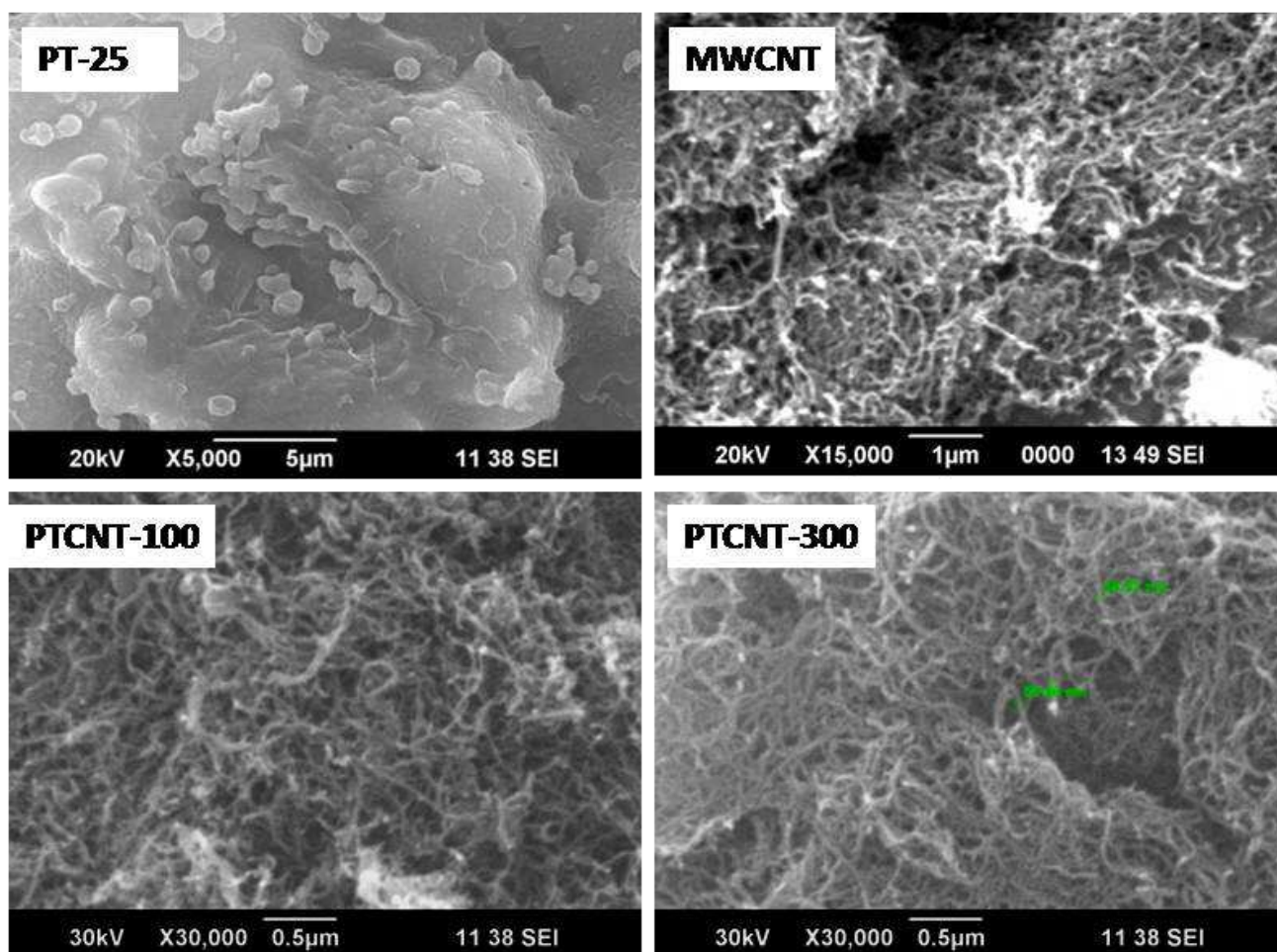


Figure 4. Scanning electron microscopy images of the PT-25, MWCNT, PTCNT-100 and PTCNT-300

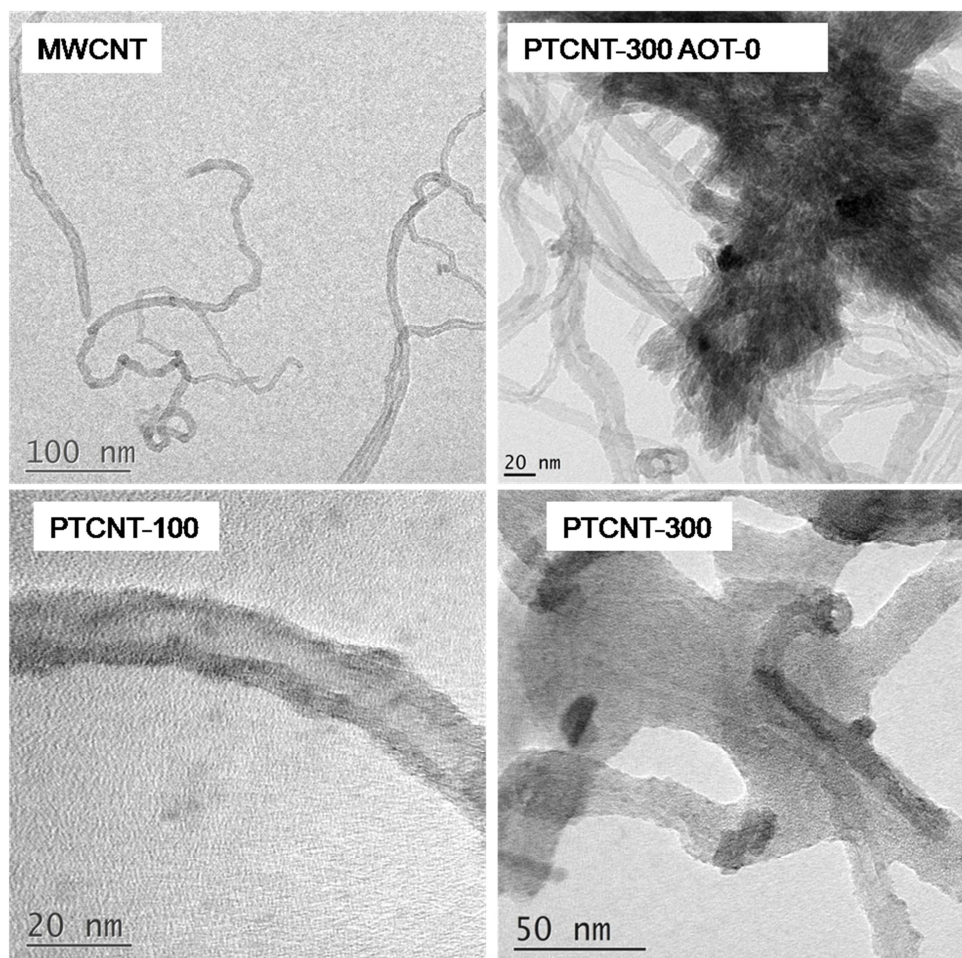


Figure 5. Transmission electron microscopy images MWCNT, PTCNT-300AOT-0, PTCNT-100, and PTCNT-300

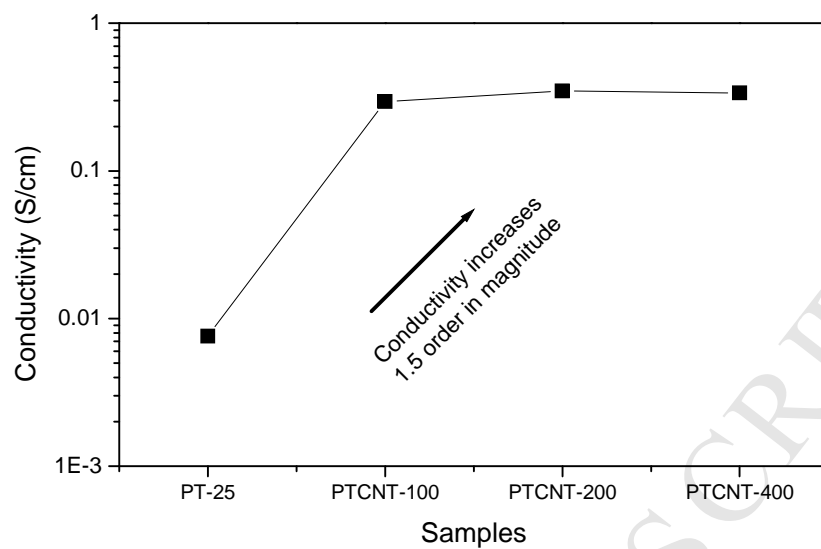


Figure 6. Four probe electrical conductivity of PT-25, PTCNT-100, PTCNT-200 and PTCNT-400.

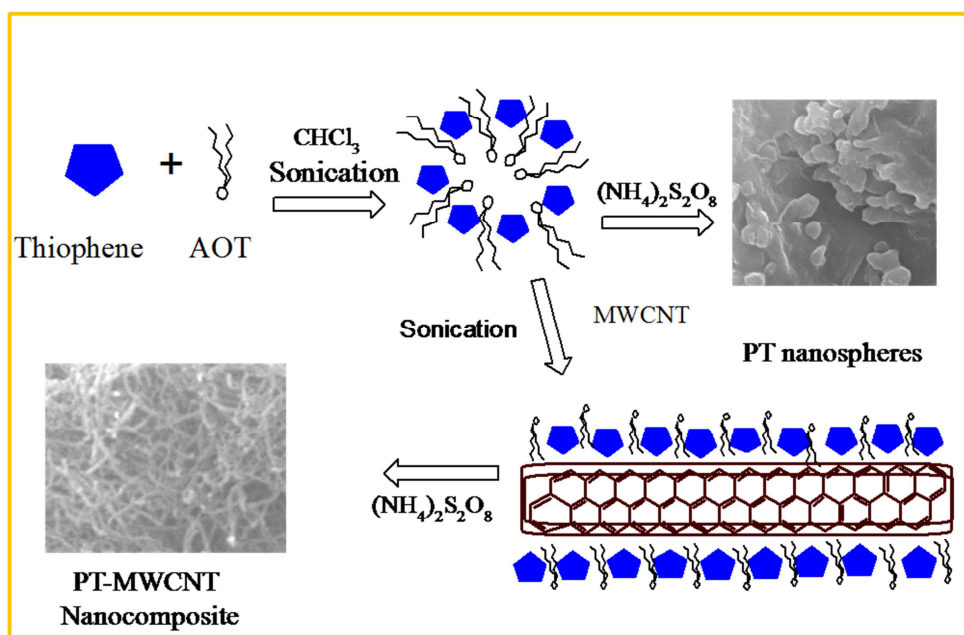


Figure 7. Formation mechanism of the core shell nanostructure of polythiophene-MWCNT nanocomposite

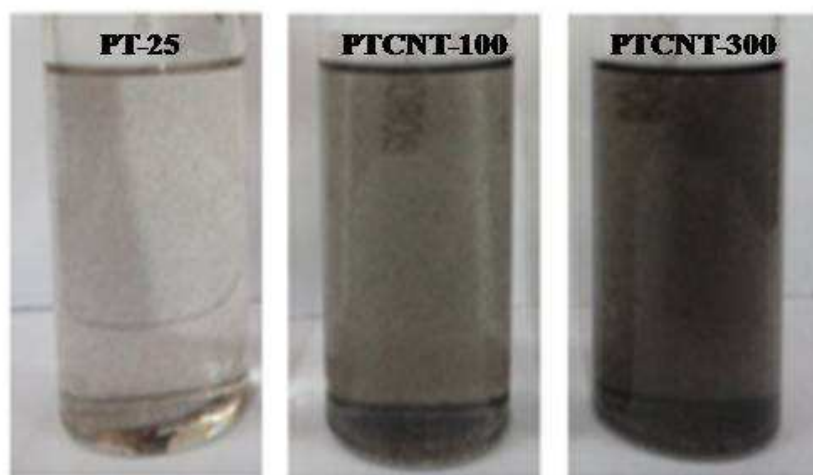


Figure 9. Dispersion of polythiophene-MWCNT (PT-CNTs) in chloroform.

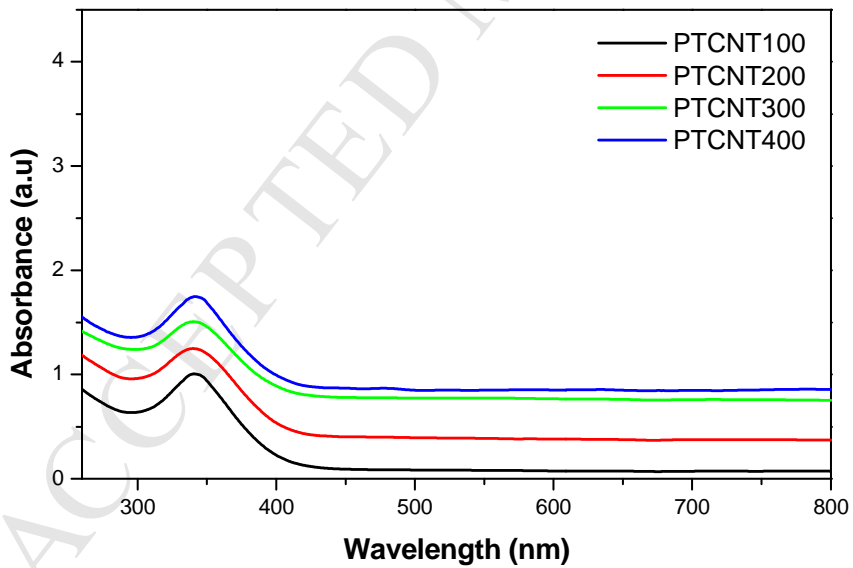


Figure 8. UV-visible absorption spectra of PTCNT-100, PTCNT-200, PTCNT-300, PTCNT-400.

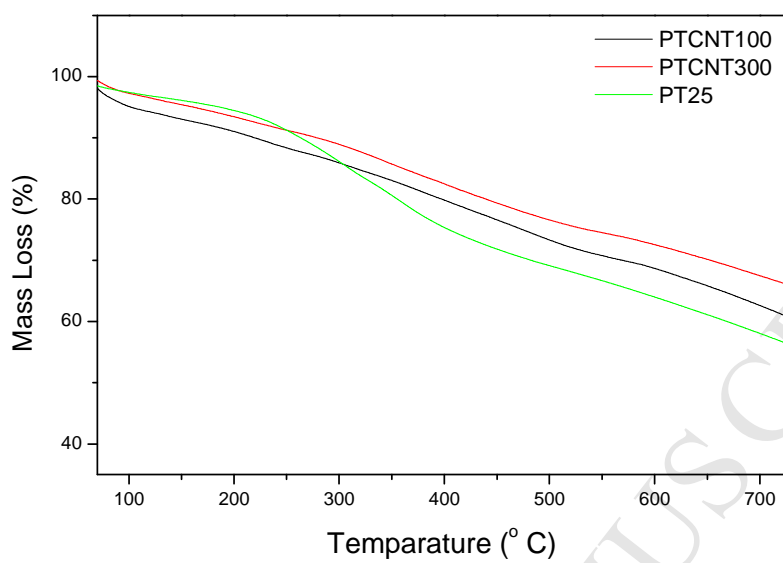


Figure 10. TGA studies of PT-25, PTCNT-100 and PTCNT-300.

Core-shell nano structured polythiophene-multiwalled carbon nanotube nanocomposites (PT-CNTs) have been synthesised by in-situ chemical oxidative polymerisation of thiophene in presence of multiwalled carbon nanotubes (MWCNT) and anionic surfactant sodium bis(2-ethylhexyl) sulfosuccinate (AOT) using ferric chloride as an oxidising agent in chloroform solution. Nanocomposites were prepared by introducing different weight percentage amount of MWCNT into a fixed monomer and surfactant composition. The formations of the polythiophene-multiwalled carbon nanotube nanocomposites have been characterised by fourier transform infrared spectroscopy and elemental analysis. Sodium bis(2-ethylhexyl) sulfosuccinate (AOT) has been used as dopant cum template for polythiophene and polythiophene- multiwalled nanocomposite preparation. WXRd studies reveal that polythiophene has shown a broad peak at 2θ value 18.23° . On the other hand, PTCNT nanocomposites were shown a sharp peak at 2θ value 26.48° and the broad peak present in polythiophene was completely vanished upon nanocomposite formation. The scanning electron microscopic (SEM) analysis of the samples reveals that PTCNT nanocomposites have a fiber like nanostructures. The core-shell nanostructure formation was confirmed by transmission electron microscopy (TEM) analysis. The outer shell thickness of the carbon nanotubes in nanocomposite increases approximately 3 nm to 15 nm from the original thickness after the formation of nanocomposite. The PTCNT samples synthesised in presence of AOT were easily dispersed in chloroform, which enabled us to carry out the UV-Visible absorption spectroscopy. The characteristic absorption peak present at 340 nm corresponds to the π - polaron transition of polythiophene. The formation mechanism of core-shell nano structured composites was proposed based on the evidence from SEM, TEM, WXRd and spectroscopic studies. The four probe electrical conductivities of PTCNT samples were of the order of 1.5 times higher in magnitude than PT samples.