Raman spectroscopy & Fourier-transform infrared spectroscopy for Ternary composites Pt: TiO_2/MWCNT

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Abstract : *Carbon nanotubes with multi-walled MWCNTs were used to impregnated two materials semiconductors and metals which are TiO2 and Pt in ternary composites Pt:TiO2/MWCNT. The ternary composites Pt:TiO2/MWCNT were characterized by using two spectrum Raman and Fourier-transform infrared that shows many information that make clear images for the nature of groups on it. The Raman spectroscopy shows that TiO2 include three phases Rutile R, Anatase A, and Brokit B with two peaks which related to MWCNTs. FTIR give the indicators that ternary composites was empty from any adsorbent H2O and G and D band.*

Keywords : *Ternary Composites, TiO2, Raman, FTIR, Photo deposition*

INTRODUCTION

The composites with binary and ternary or poly materials represent one of the most techniques that used to find best applications for physical and chemical properties of materials [1]. The aims for synthesis composites not only enhance the properties of mixture but also to shows Multifunctional abilities for the new materials. Composites could be synthesized by different methods such Hydrothermal, Sol–gel synthesis, polymerized complex method, Chemical vapor deposition, polymerized complex method and Microwave synthesis [2]. All of the methods which mentions previously characterized by specific properties for synthesized composite with special behavior. The composite can be classified to Polymer nanocomposites, Novel metal-based nanomaterials, Catalysts, Sensors, and Bioengineering [3]. The enhancement in properties or appearance multifunctional for new materials can be related to increase surface area, conductivity, resistance to oxidation and reduction agents or strength in structure. As we mentions before ternary composites refers to three materials in the same cotenants with different ratios mostly one of them take higher value while the other complete the new behavior with different ratios [4]. The common ternary composite was Pt:TiO2:CNT [5-6] due to many causes such the new material carbon nanotubes , noble metals Pt and cheap nontoxic Titanium dioxide. Many techniques were used to characterized composites such as X-ray family (XRD, XRF, EDX, XPS) [7], scanning / transmission electron microscopy, SEM /TEM and Raman spectroscopy [8]. Raman and Fourier-transform infrared spectroscopy represent the most important instrument which used together for making clear images about the nature of bonding in the carbon nanotubes with many bonding species. Many literatures were reported many information about these two techniques when spectra that contain signals from the organic functional groups in the sample. The bands in FTIR are related to the groups with polar behavior while the bands in Raman are related to nonpolar groups, thus FTIR and Raman spectroscopy are complementary techniques [9]. In this work ternary composites were synthesized by simple evaporation/photo-platinazation methods was characterized by Raman spectroscopy and Fourier-transform infrared spectroscopy.

Experimental

I. Materials

Multi-walled carbon nanotubes MWNTs, were purchased from Aldrich, which fabricated by chemical vapor deposition method. The purities of MWNTs 95% and mode diameter 5.5nm. The TiO2 sample was purchased from Degussa, Germany (TiO2-P25) consist of 20% Rutial and 80% Anatase. The source of Pt was hexachloro platonic (IV) acid hexa hydrate (H2PtCl6.6H2O) where purchased from Riedel-De-Haen AG, Seelze, Hannover, Germany. Methanol (A.R quality, 99.9%) was supplied from Hayman, England. The work was done in Institute of Technical Chemistry, Leibniz Universität Hannover\Germany.

II. A. Preparation of Binary and ternary composite

Ternary composites was prepared when impregnated MWCNTs with TiO2 by a simple evaporation method and photo-platinazation [5]. At first 100mg of MWNTs was treated with 60 ml of mixture HNO3/H2SO4 (1/3) with using ultra-sonic water bath for 7h then washing and drying at 100°C. The required amount of activated MWNTs and TiO2 was dispersed in 200 ml of distilled water by using ultra-sonic system for 20 min to forming TiO2/0.5%MWNT. The TiO2 / MWCNT was platinized, by photo-deposition method when mixture of 37% formaldehyde: absolute ethanol (4:1) was added to the aqueous suspension. The deposition was accrued with UV light irradiated for 3hour at 40°C, using a 200-W mercury lamp to produce 0.5%Pt:TiO2/MWCNT .

III. Raman spectroscopy for Pt:TiO2/MWCNT

Raman spectroscopy for pure TiO2 include characteristic bands for two phases' anatase and rutile. Anatase modes appears at 150 cm-1 (Eg), 395.1 cm-1 (B1g), 512.5 cm-1 (A1g + B1g) and 636.7 cm-1 (Eg) respectively [10.]. Rutile phase appears at 143, 235 cm-1 which can be ascribed to the B1g, two-phonon scattering, 445 cm-1Eg, and 612 cm-1 A1g, respectively [11]. All the peaks which mentions above were founded in ternary composites as pointed in part 2 and 3, the influence shown as more broad for the peaks with distortion in the region 1due to precipitation Pt. The Raman spectra with MWNTs showed a G band at 1582 cm-1 corresponding to the wrapped graphene plane and a D band at 1330 cm-1 for the C-related defects of MWNTs [8] which represent in part 5. The part 5 shows also existed carbonyl grops that due to oxidation process from the activation by HNO3/H2SO4. In the case of TiO2/0.5%MWNT composites, all the Raman bands for anatase and MWNTs remain, except slightly broadened. The ternary composite shows the two effects for MWNTs and Pt with TiO2.

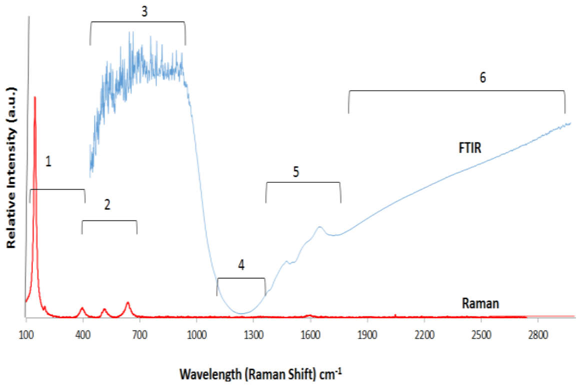

Fig. 1: Raman and Fourier-transform infrared spectroscopy for ternary composites Pt:TiO2/MWCNT

IV. Fourier-transform infrared spectroscopy FTIR

The absorbance intensity of FTIR with wave length included three parts: the first part 3 which starting from 400-950 cm-1.

The second in part 5 cam be related to D and G as mentions before with Raman spectroscopy [12] that include the oxidized MWCNTs and the TiO2-MWCNT/ composite. The Bands in part 5 at 1575, 1653 and 1713 cm−1attributed to C= C, carbonyl and carboxyl, respectively were refers successful oxidization. The FTIR spectrum of TiO2-MWCNT shows a peak at 680 cm−1dueto Ti –O- Ti vibration beside those exhibited for carbonyl and unsaturated carbon. The spectrum in part 6 for Raman and Fourier-transform infrared spectroscopy give important information about not excited any adsorbent or remaining H2O with the ternary composites. The identifications of Pt which may excite banding as Pt:TiO2 and Pt:MWCNT could be not easy with FTIR due to appears in the region 500-900 cm-1 . Thus technical rearrangements should be taken before analyzed the material to ensure identified Pt.

V. HR-TEM image

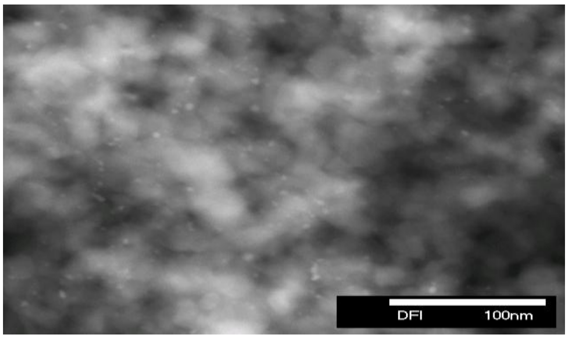

Figure 2: HR-TEM image for ternary composites Pt:TiO2/MWCNT

Figure 2 shows the HR-TEM images for synthesized ternary composites which taken by High- resolution transmission electron microscopy HR-TEM from JEM-2100F Japan. The image was shows many particles of Pt was on the surface of TiO2 and MWCNTs with average particle size 4-8 nm. The filaments of MWCNTs were appeared on the lower part of image and that include few particles of Pt that precipitated on the surface. May be the lower ratios of MWCNTs and sample piratical size for Pt as compare with CNTs causing reduces the appearance of MWCNTs.

Conclusion

Raman spectroscopy and Fourier-transform infrared spectroscopy commonly known as complementary instruments and sources for many information's that deals with the nature of ternary composites or any materials. The benefit not to identify the materials but also to give information that could not appears in typical conditions. The efficiency of Raman spectroscopy and FTIR may be in sometimes Fail or miss the abilities to make complementary and ideal identifications which limit the techniques**.**

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