Study The Structural Properties of Polyaniline:PEDOT Nano Composite.

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Abstract:

In this research we study the structural properties of pure polyaniline films and doped with poly(3,4-ethylenedioxythiophene) PEDOT. The study included the preparation of films on the rules of the glass and then conducted the tests, infrared , X-ray diffraction and AFM. In this study found that polyaniline was randomly, when you add PEDOT, it cannot happen interaction between them, but be attending together. The results of the tests (**AFM**) of the all films are uniform granular surface morphology. The roughness, root mean sequare and average grain diameter, they were increasing with increased of doped ratio. The method of films preparation are made by spin coating technique.

Keywords: Structural Properties, Polyanilin, Thin Films, PEDOT

1-Introduction:

Conjugated polymers such as polyaniline (PANI), are the most interesting because of its excellent chemical stability . They are easy to prepare in the form of large area thin films and able to storage the charge throughout the entire size[1,2,3]. The chemical composition of polyaniline consists of vinyl ring with a (N-H Group) on both ends of the loop itself,As in Figure (1) [4, 5].
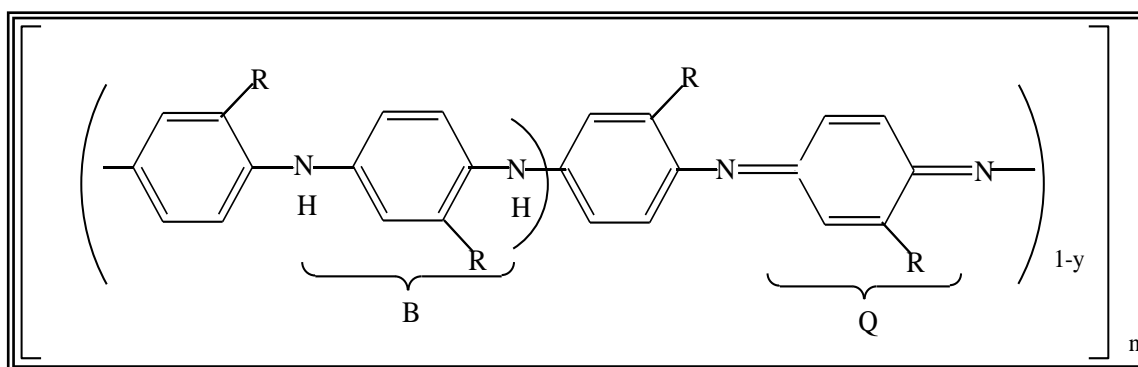

Figure (1) the general formula of polyaniline

So the (PANI) can exist with different Structures depends on the value of (Y) (the degree of oxidative stress) in the general formula[6]. The temperature has a significant effect on the polymers preparation , as conducting polymerization degree in low-lying temperature leads to the formation of polymer with a high conductivity compared with polymers preparation at high temperatures [7,8]. The mechanical properties of poly Aniline be weak Also it features properties Photoelectric could be using in industrial applications, for example the light-emitting diodes [9,10].

2-Practical Part :

2.1- Preparation of Films :

Were prepare films by depositing material on the pieces of glass using a method (Spin coating method).) after Cleaned it well.

2.2- Prepare The Solution Used for Doped:

It has been added PEDOT to the polymer By certain percentages, that the films thickness is 48 nm.

2.3-   Diagnostic Tests:

2.3.1- FTIR Diagnos:

Using IR spectroscopy in the study of the structures of polymers , through knowledge of the active groups of the polymer which linked to some of the groups with the compound and the disclosure of the type bond that bind molecules article, It has been by using Vertex 70 from bruker company, at Babylon University / College Basic Education, Department of General Science**.**

2.3.2- XRD:

This method is adopted to study the crystal structure of various materials, whether powder or thin films.

2.3.3-Atomic Force Microscope (AFM):

Atomic force microscope (AFM) is an instrument that extremely high-resolution type of scanning probe microscopy, where through which to look at the surface of a very high accuracy from (100 μm to less than 1μm)[11]. AFM is used for surface imaging technology to obtain information about The morphology of the film, such as, standardization, and distribution of grain or defect Forming a film on any surface, such as insulation or procedure without Damaging the surface. It has been investigated a wide range of materials using This technology, including semiconductors, polymers, metals and composites[12] . This device is present in the laboratory at the Department of chemistry / College of Science/ University of Baghdad.

3- Results and Discussion:

3.1 – FTIR:

The FT-IR spectrum was recorded for the synthesized sample in the wavelength range of $(4000-400)cm^{-1}$. **Figure (2)** show the FT-IR spectrum of pure polyaniline (PANI). The characteristics peaks of PANI including peaks range $(3003.17-3529.73)$ cm^{-1} corresponding to (N–H stretching vibrations of secondary amine) , $(2723.49 – 2939.52)$ cm^{-1} corresponding to (C–H vibration of in CH_2) , $(1516.05 – 1668.43)$ cm^{-1} corresponding to (C=C stretching of quinoid ring), 1469.76 cm^{-1} corresponding to (C=C stretching vibration of benzenoid ring) , $(1313.52- 1382.96)$ cm^{-1} corresponding to (C - N stretching of primary aromatic ring), $(1111.00- 1157.29)$ cm^{-1} corresponding to (Aromatic C–H in-plane bending vibrations) and $(619.15 – 889.18)$ cm^{-1} corresponding to (Aromatic C–H out-of-plane bending vibrations).

Figure (3) for (PANI+PEDOT) $(3219.19 – 3606.89)$ cm^{-1} corresponding to (N–H) stretching vibrations of secondary amine) , 2827.64 cm^{-1} corresponding to (C–H vibration of in CH_2), 1631.78 cm^{-1} corresponding to (C=C stretching of quinoid ring),$(1402.25-1481.33)$ cm^{-1} corresponding to (C=C stretching vibration of benzenoid ring),$(1311.59-1357.89)cm^{-1}$ corresponding to (C - N stretching of primary aromatic ring), $(1091.71-1193.94)$ cm^{-1} corresponding to (Aromatic C–H in-plane bending vibrations) and 981.77 cm^{-1} corresponding to (Aromatic C–H out-of-plane bending vibrations

The FT-IR spectrum of poly (3,4 – ethylenenedioxythiophene) (PEDOT**) Figure (4)** showed broad stretching peak at $(3402.43-3462.22)$ cm^{-1} corresponding to (Aromatic C–H) , 2887.44 cm^{-1} corresponding to (stretch group CH_2 in PEDOT) , 1633.71 cm^{-1} corresponding to (C=C stretching of the quinoidal structure of the

thiophene ring), (1301.95 -1404.18) cm^{-1} corresponding to (C-C stretching of the quinoidal structure of the thiophene ring) and (1076.28-1209.37) cm^{-1} corresponding to (C-O-C bound stretching in ethylene dioxy group). **and coincides with the literature as wel**[13].
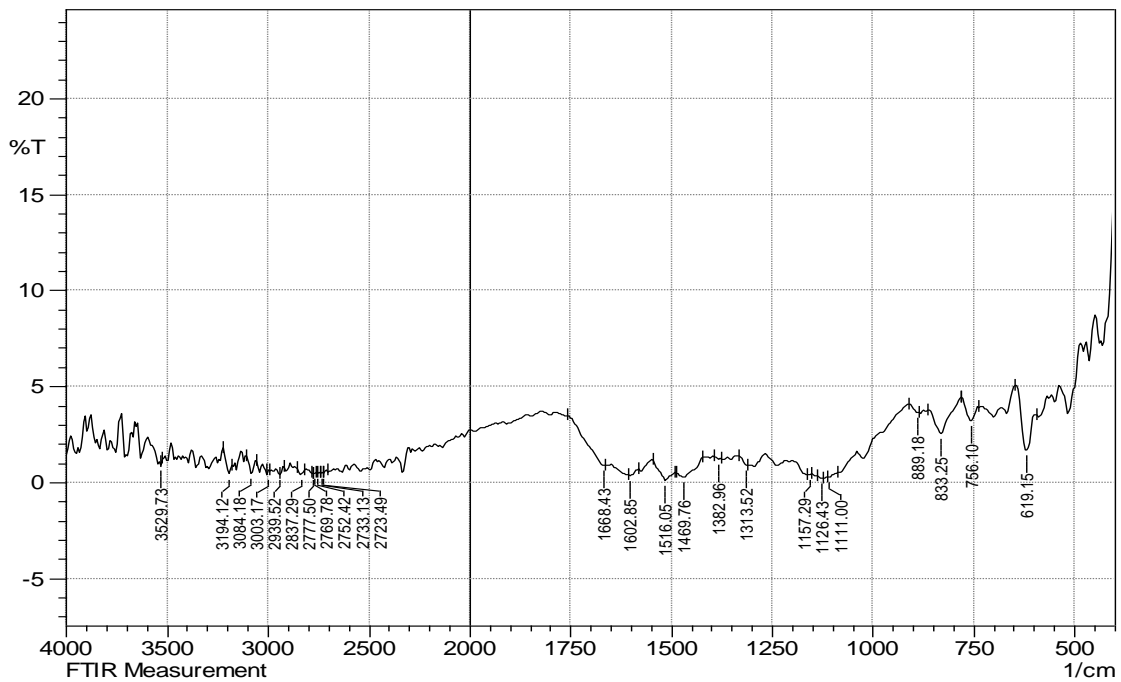

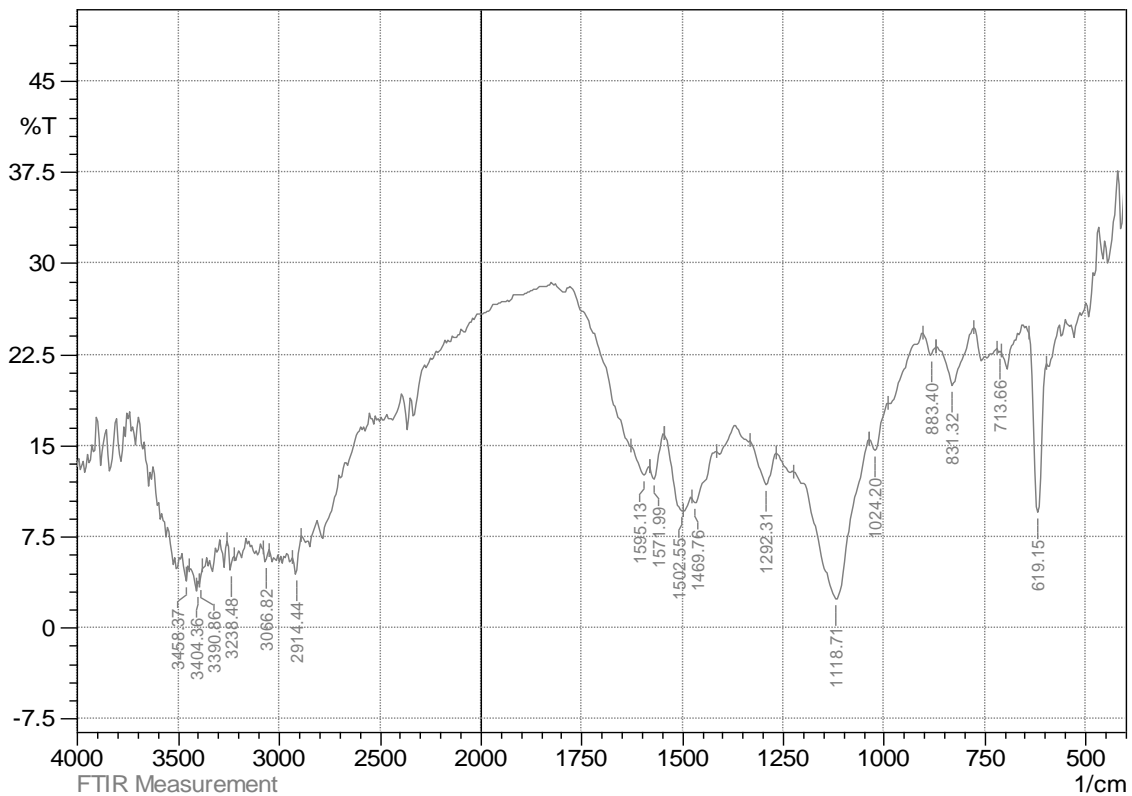Figure (2) FTIR for pure polyaniline

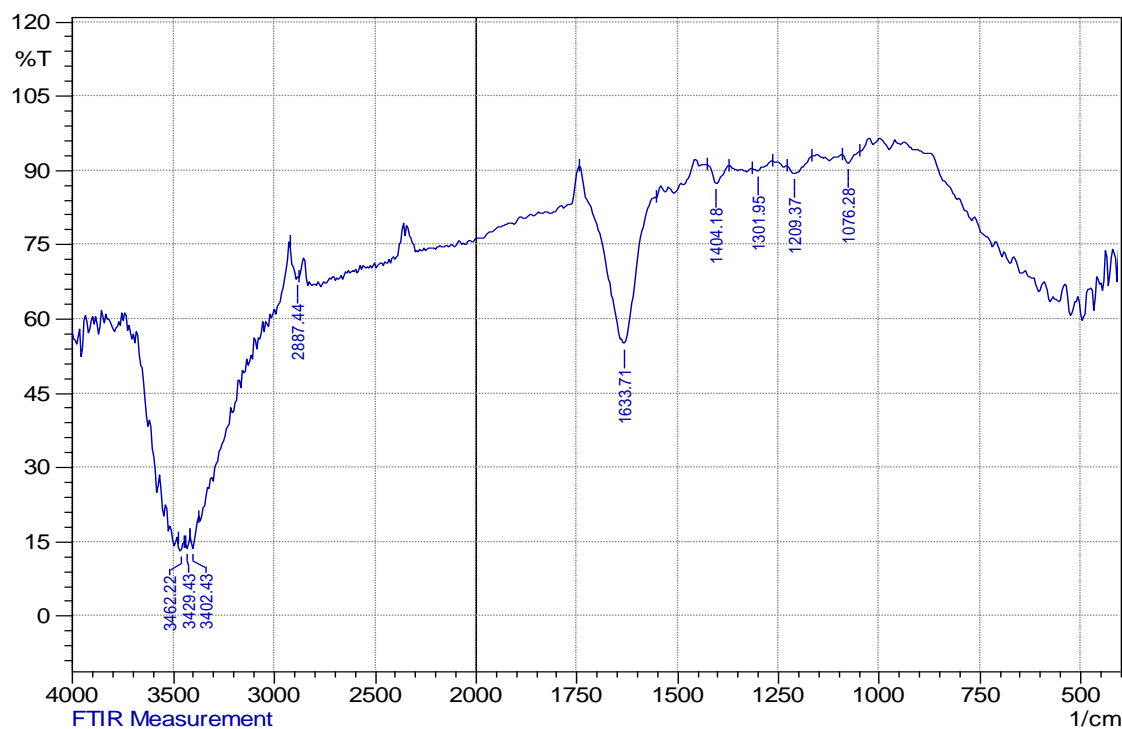

Figure (3) FTIR for polyAniline / PEDOT

Figure (4) FTIR for poly(3,4-ethylenedioxythiophene) PEDOT

These results indicated to the presence of each of the polyAniline and poly(3,4-ethylenedioxythiophene) which indicates to Their presence together.

3.2 XRD:

Figure (5) which represents the X-ray diffraction of pure poly Aniline , appears broad summit at (250) which shows that the poly Aniline is (Amorphous) while figure(6) represents X-ray diffraction of the poly-aniline doped by Carbon nanotubes with ratio 1% ,where notes the appearance of two peaks at $(10^0$-$30^0)$. An angle (16^0) shows the diffraction for the parallel levels in the polymeric chain, an angle (33^0) shows the diffraction of the levels orthogonal.
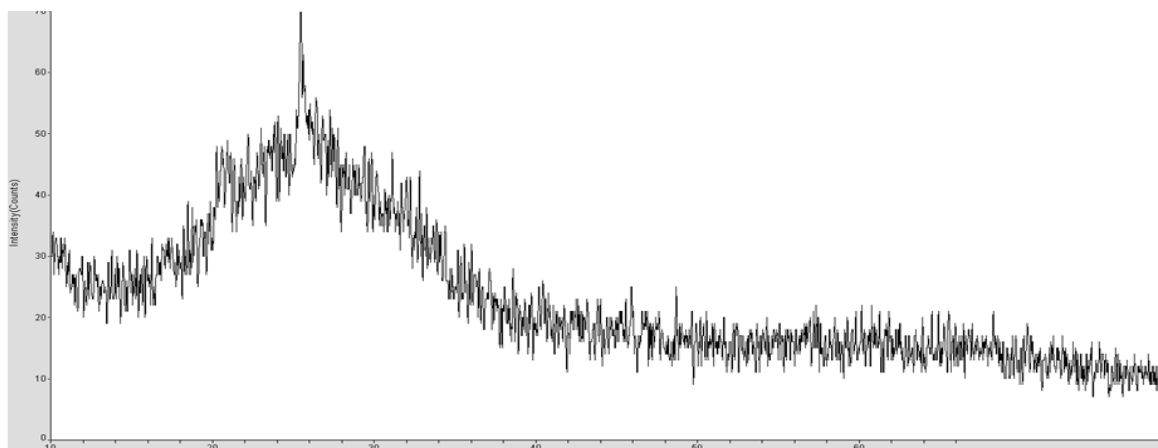
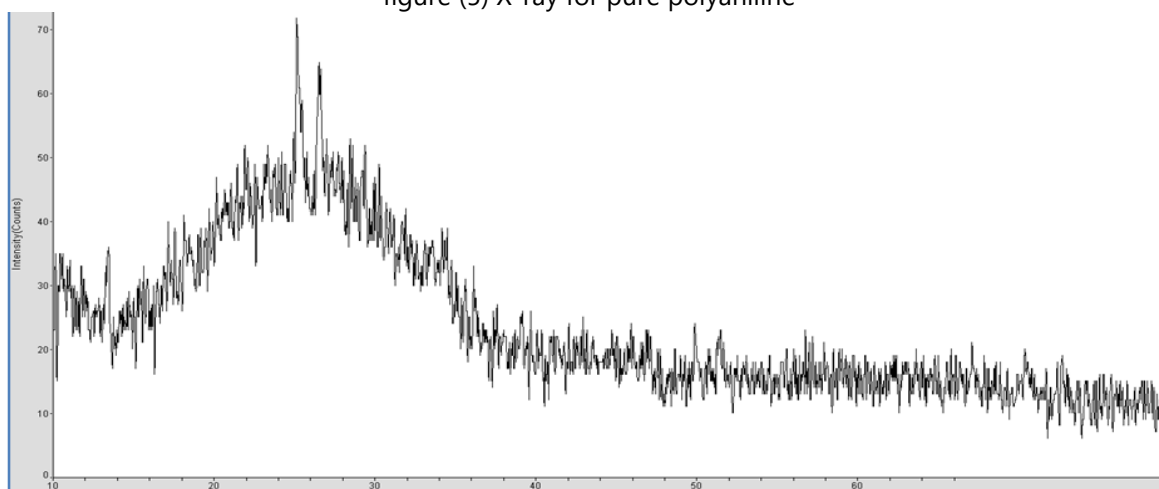figure (5) X-ray for pure polyaniline

figure (6) X-ray for polyaniline / PEDOT

3.3- AFM

The results of the tests (**AFM**) of the nano films for pure (PANI) and doped with different ratio of(PEDOT) films which prepared by spin coating which showed a uniform granular surface morphology, as in Figure (7,8,9,10) . Where we note that the roughness increased with increasing the ratio of doped. As well The root mean sequare (RMS) increased with increasing of ratio of doped, the average grain diameter also It exhibits the same behavior . as in table (1). This is consistent with the findings of the researchers (13, 14).
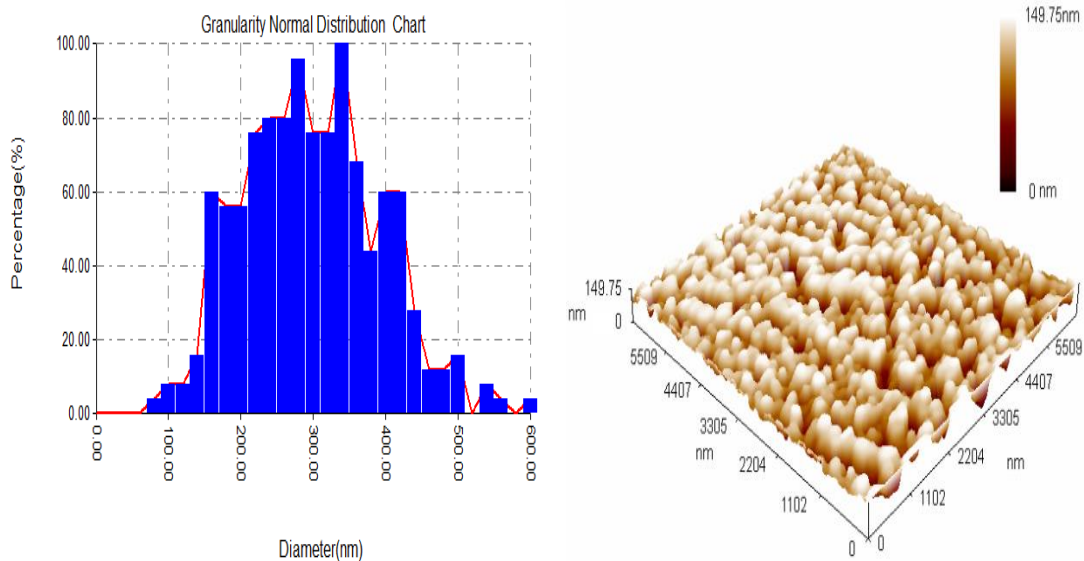
(a)   (b)

Fig.(7) AFM images of pure PANI nano films for(a) 3-D and (b) granularity   accumulation distribution
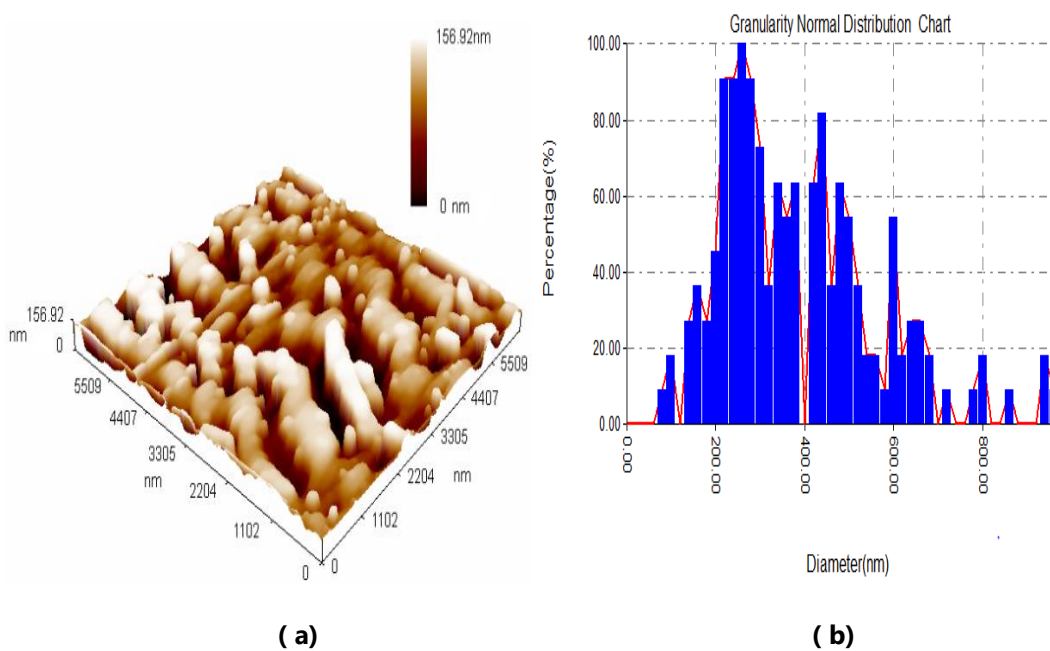
(a)   (b)

Fig (8) AFM images of PANI/ PEDOT with ratio 1% for (a) 3-D and (b) granularity   accumulation distribution

(a)   (b)

Fig (9) AFM images of PANI/ PEDOT with ratio2% for (a) 3-D and (b granularity   accumulation distribution

(a)   (b)

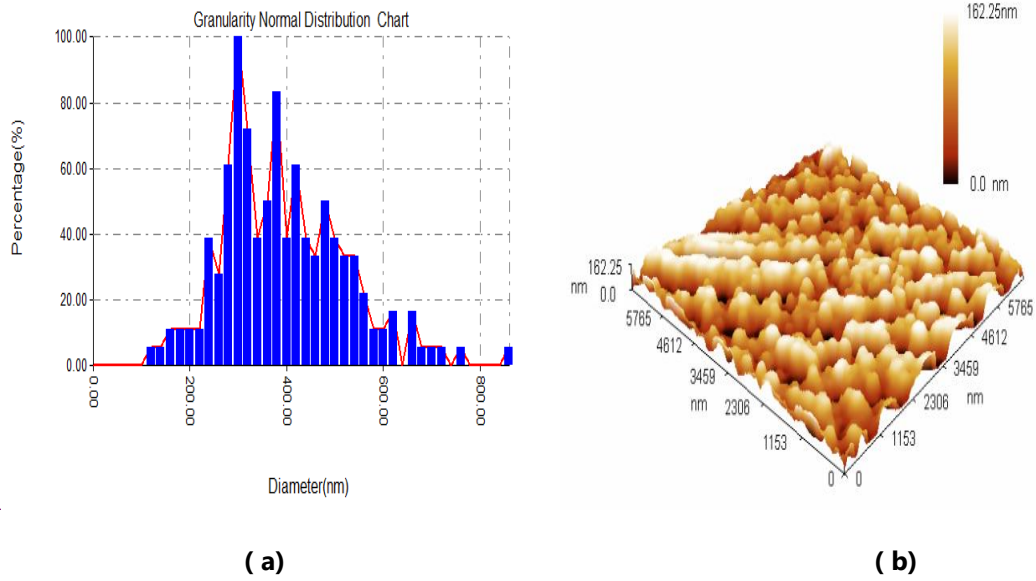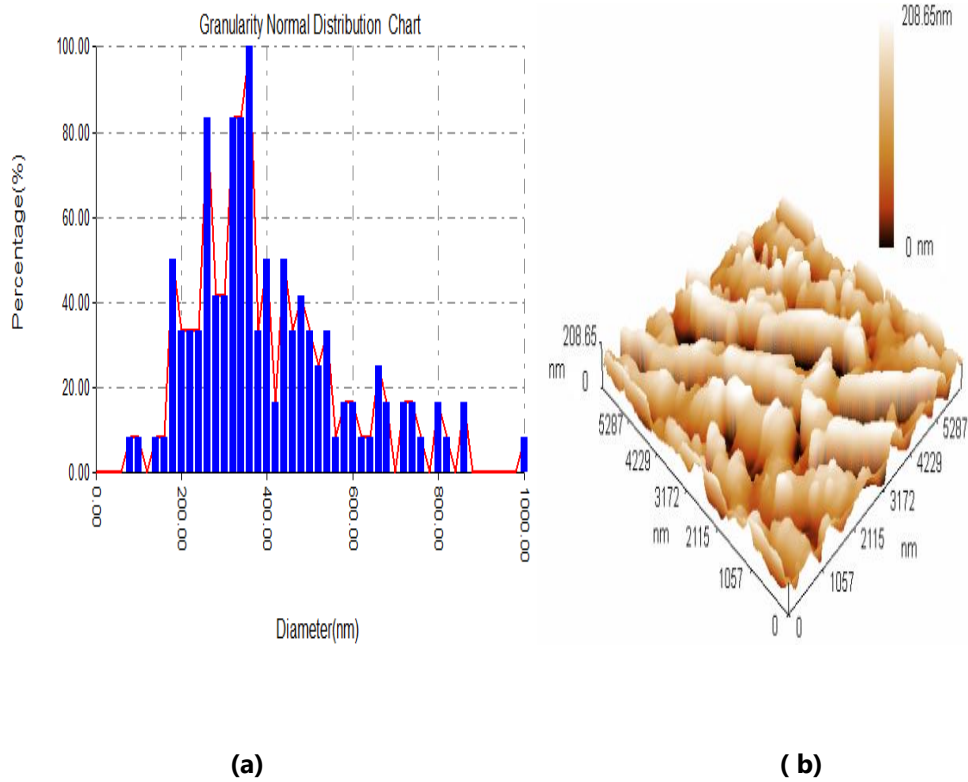**Fig (10) AFM images of PANI/ PEDOT with ratio 3% for (a) 3-D and (b) granularity accumulation distribution**

Table (1) Morphological characteristics of PANI/PEDOT nano films deposited at different doping concentration

Sample	PANI/PEDOT(wt%)	Roughness average Sa (nm)	Root mean square Sq (nm)

1	0	25.1	31
2	0.01	35.9	42.6
3	0.02	40.6	46.8
4	0.03	52.2	60.2

4. Conclusions

The summarized results from this work are the following:

1. It is found through a study that these polymers possess random installation.

2. The addition of poly(3,4-ethylenedioxythiophene) PEDOT does not change the installation of the polymer but are attending together.

3. all films are uniform granular surface morphology.

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