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Nonionic Surfactant Impact on Polyaniline-Graphite Nanocomposites

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Abstract: *Composite materials have many advantages over monolithic materials are playing an vital role in the field of materials science and the nano-composites provide reinforcing efficiency because of their high aspect ratios. The polyaniline has the numerous applications and graphite is a good electrical and thermal conductor. A surfactant is a surface active agent which tends to accumulate at a surface or interface. The nanocomposites treated with surfactants may alter the morphology and the particle size.*
Keywords: *Polyaniline,graphite. surfactant, triton x-100,Lauryl alcohol, nanocomposites.*

I. Introduction

Composite materials posses most desirable properties which are not present in the individual phase. The nanocomposite has at least one dimension less than 100nm. The nanocomposite materials have emerged as suitable alternatives to overcome limitations of micro composites and monolithic [1]. The Polyaniline (PANI) belongs to the group of electronically conducting polymers, which are of great interest for practical applications at present. Conductive PANI has been studied extensively because of its ease of synthesis. It can be synthesize by chemically or electrochemically. The numerous methods employed to synthesize this material have produced several products, which differ in their nature and properties and must represent the result of multitude of polymerization mechanisms of aniline. The aniline polymers are on limelight because of their environmental stability, controllable electrical conductivity and interesting redox properties associated with the nitrogen atoms in the main chain. The PANI has numerous applications [2-4].

Graphite (GRA) is a crystalline form of carbon, naturally occurring, steel-gray to black. It consists of carbon layers and each carbon layer is called graphene layer and it is a good electrical and thermal conductor within the layers and a poor electrical and thermal conductor perpendicular to the layers[5]. A surfactant is a surface active agent which tends to accumulate at a surface or interface. Depending on the chemical structure of the hydrophilic moiety bound to the hydrophobic portion, the surfactant may be classified as cationic, anionic, nonionic or zwitterionic. The adsorption at interface and prevention from gross aggregation of particles, these are the two important properties of the surfactant[6-8].The Triton X-100(poly oxyethylene tert-octylphenyl) $C_{14}H_{22}O(C_2H_4O)_n$ is a nonionic surfactant obviously affected the particle size and distribution[9].The synthesis process of nanocomposites is also treated by a an surfactant lauryl alcohol(also known as 1-dodecanol)and the chemical formula is the [$CH_3(CH_2)_{10}CH_2OH$] (also written as $C_{12}H_{26}O$).Thus the object is to investigate the effect of surfactants on the size and morphology on the nanocomposite. In this work the polyaniline-graphite(PANI-GRA) composite with 10wt% of graphite content is chosen and the three different samples of selected composite material without surfactant, with surfactant triton X-100 and lauryl alcohol are synthesized and are characterized with XRD and SEM. The influence of surfactants on particle size and morphology of the product was discussed

II. Experimental Procedure

2.1 Materials

The analytical grade materials are used to synthesize the required samples. Aniline purchased from Central drug house (P) Ltd., New Delhi India, ammonium-persulphate and graphite powder from Qualigens fine Chemicals Mumbai, India and demineralised water from Nice Chemicals (p) Ltd. Kochi, Kerala, India, and Triton X -100 from Himedia Laboratories pvt. Ltd. Mumbi and lauryl alcohol from Central Drug House New Delhi, India.

2.2 Synthesis of PANI-NANO composite.

The graphite powder washed with acetone and dried for three days. The solution of 0.2 M aniline ($C_6H_5NH_2$) and 0.1 M ammonium persulphate [$(NH_4)_2S_2O_8$] was prepared in 1 M HCl in two separate flasks demineralized water and 10wt% of graphite powder is added. These solutions were slowly mixed under continuous stirring at room temperature, the initial colorless solution slowly turned green. After completion of the reaction, the resultant product was repeatedly washed in Buchner funnel with distilled water till filtered solution turned from acidic to neutral. Finally, it was washed with acetone to remove low-molecular weight intermediates of aniline (brown colored solution). The dried material is the plane PANI-GRA composite with 10wt% GRA and is grinded to fine powder and stored in a sealed bottle for further process.

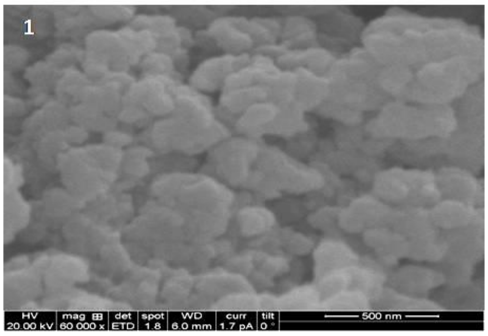
2.3Synthesis of PANI-GRA nanocomposites with Surfactants:

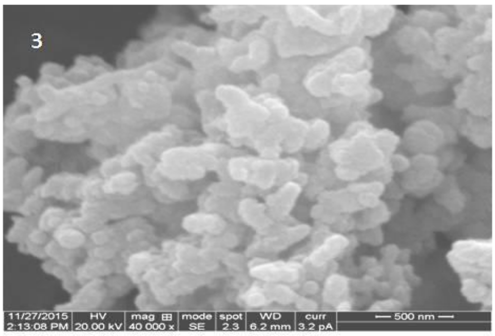
The above mentioned procedure is repeated to prepare two PANI-GRA composites of same composition treated with surfactants; one surfactant is triton X-100 and the other is lauryl alcohol. In each case the surfactant was added during the mixing of aniline and ammonium-persulphate. The prepared samples were grinded to fine powder and stored in a sealed bottle for further process.

III. Results And Discussion

The PANI-GRA composites containing 10wt% of GRA without and with surfactants were prepared by chemical root method. The surface morphology of composites was studied using scanning electron microscope (SEM). The crystalline nature and particle sizes of all the three composites were analyzed by using XRD patterns which were obtained using CuKa radiation at a scanning rate of 2.0mm/min., using a voltage of 45 kV and a current of 40 mA.

The Figure-1 shows a 60k x magnified SEM image of bare PANI-GRA composite (without surfactant), the wide dispersion of filler particles (GRA) in the matrix (PANI), confirms the formation of nanocomposite. The Figure-2 is the 40k x magnified SEM image of PANI-GRA composite, treated with an surfactant triton x-100 and the Figure-3 is the 40k x magnified SEM image of PANI-GRA composite, treated with an surfactant lauryl alcohol. The images indicate that both the dispersion and interface between the filler particles and matrix can be significantly improved after surfactant treatments. The increment in homogeneity and decrement in particle size also can be observed. Thus the surfactants influence the physical and chemical properties of the





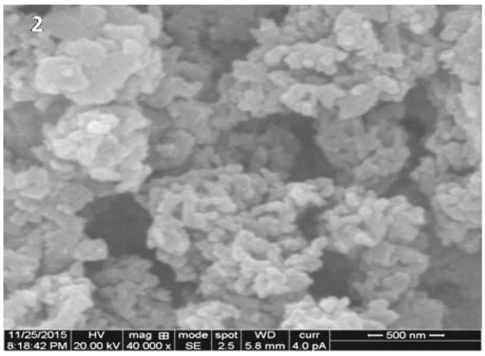


Fig.1: SEM image of plane PANI-GRA nanocomposite.

Fig.2: SEM image of PANI-GRA nanocomposite treated with triton x-100.

Fig.3: SEM image of PANI-GRA nanocmposite treated with Lauryl alcohol.

composites.

The Figure-4 is the XRD pattern of plane PANI-GRA composite with 10wt% of GRA. The pattern indicates that there is no impurity in the powder. The highest single sharp peak was observed at $2\theta=21.42^{o}$, hence the composite formed is crystalline in nature and verify the presence of filler nanoparticles in the polyaniline matrix. The average size t was estimated using Scherrer's equation

$$t = \frac{k\lambda}{B\cos\theta}$$

Where λ= 1.5418 Å (Cu) is the X-ray wavelength, k is the shape factor=0.89, θ is the Bragg angle in degree, and B is the full width at half-maximum (FWHM) measured in radian [10-11]. The estimated average particle size is 38.32nm.

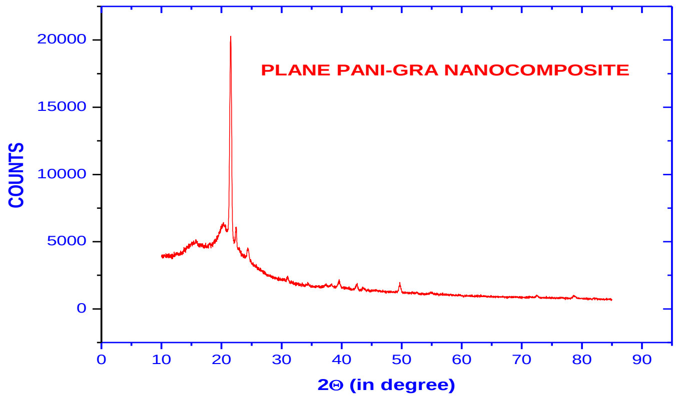


Fig.4:XRD of plane PANI-GRA nanocomposite

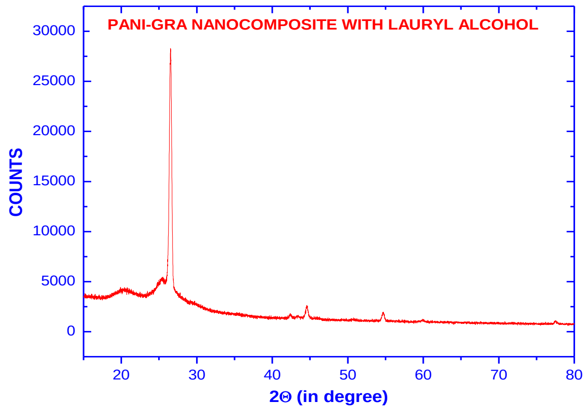


Fig.5: XRD of PANI-GRA nanocomposite treated with lauryl alcohol.

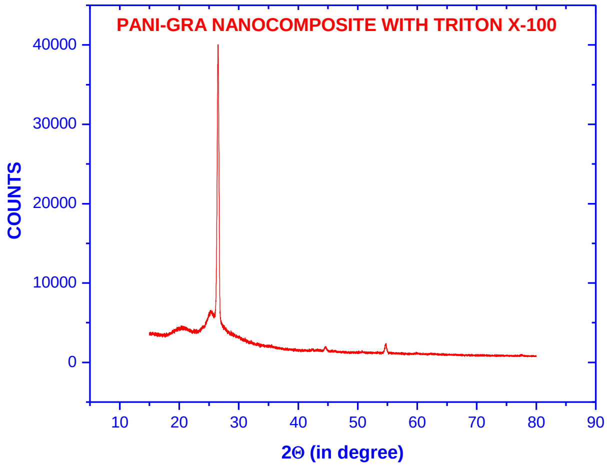


Fig.5: XRD of PANI-GRA nanocomposite treated with triton x-100.

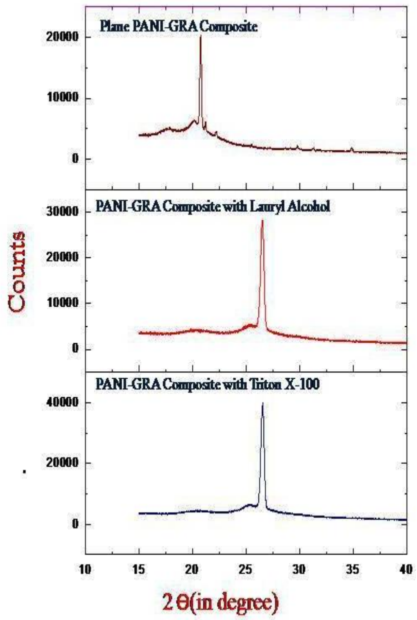


Fig. 6: Combined XRD of three nanocomposites shows peak shift towards higher value of 2θ

The Figure -5 shows the XRD pattern of PANI-GRA doped with lauryl alcohol, the highest single peak can be observed at 2θ=26.50°,the estimated particle size is 19.38nm.The peak intensity increases and shifted towards the higher angle indicates the decrease in lattice parameter. Thus the composite treated by the lauryl alcohol leads to decrease in particle size and lattice parameter. The Figure -5 shows the XRD pattern of PANI-GRA doped with triton x-100, the highest single peak can be observed at 2θ=26.53°,with estimated particle size 20.88nm and also rise in peak height. The Figure-6 shows the comparative XRD patterns of the three samples.

IV. Conclusion

The PANI-GRA composites weres synthesized successfully without and with nonionic surfactants. The SEM images show that the treatment with surfactants had considerable impact on the surface morphology of PANI-GRA composites. The XRD patterns reveal that surfactant had a considerable effect on the particle size and lattice parameter of the resulting product. The changes in the nanosizes of the particles were confirmed. Hence we succeed in synthesis of nanocomposites of PANI and GRA with and without surfactant.

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