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Structural & Optical Properties of Copper (Cu) doped Polyaniline

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ABSTRACT: In the study, Polyaniline (PANI) and Copper (Cu) doped PANI was synthesized by using spin coating technique where copper selenide (Cu_2Se) used as a dopant. The structural characterization was carried out using X-ray diffraction (XRD). The optical properties were made from UV-Visible spectrometer at normal incidence light wavelength in the range of 330-1100nm. The characteristic peaks UV-Visible spectra were found shifted to higher wave numbers. An orderly arrangement of the polymer composite obtained from XRD.

Keywords: XRD, PANI, Nanocomposites, Absorbance

I. INTRODUCTION

Among the conducting polymers, Polyaniline is considered because of its easy synthesis, low cost, good environmental stability, and easy solution processing etc. All these forms are insulators [1]. Only the protonated form of polymer system can show metallic conductivity. A polymer to become electrically conductive, it must imitate a metal, which means that electrons in polymers must be free to move. Polyaniline (PANI) has been widely studied for electronic and optical applications [2-3]. Its excellent stability to air oxidation, tunable electrochromic behaviour, controllable electrical conductivity and simplicity of preparation from cheap materials make it superior to other conducting polymers [4]. Because of these peculiarities, PANI has found a wide range of applications in preparing light-weight batteries, electro chromic devices, sensors and electroluminescent devices. Recently, polymers containing a chalcogenide, selenium, have exhibited promising properties as organic superconductors [5-6]. Tetraselenesulfalene and other Se containing organic compounds have displayed metal to semiconductor transitions at low temperatures. Various dopants have been used elsewhere in order to enhance the conductivity of PANI [7]. However, studies on polyaniline doped with chalcogenides like Selenium (Se) and its compounds are less. Among chalcogens selenium is of importance because of its applications in electronics, in photovoltaic, and as superconductors. In our present study, polyaniline was synthesized by conventional method and doped with copper selenide by in situ polymerization technique which is hitherto not reported. The as-prepared samples were characterized by Fourier Transform Infra Red (FTIR) and optical measurements were made from UV-Visible spectrophotometer (V-670 JASCO), at normal incidence light wave length.

II. SYNTHESIS OF PANI

In the present work, materials such as Hydrochloric acid (HCl) (SDF), Ammonium persulphate (APS), Sodium Hydroxide (NaOH), Cuppric Nitrate ($Cu(NO_3)_2.3H_2O$) and metal Selenium were used. Aniline (AR grade, Ranbaxy) is double distilled before use for better results.

Polyaniline was synthesized by the polymerization of aniline in the presence of HCl (acts as a catalyst). The technique adopted here was an oxidative coupling involving the oxidation of monomers, to form a cation radical followed by coupling to form di-cation and the repetition leads to a polymer [8].

III. SYNTHESIS OF POLYANILINE - COPPER SELENIDE (Cu_2Se) COMPOSITE

The nanocomposite was prepared by dispersing the synthesized Copper selenide nanoparticles in the mixture of HCl (1M) and aniline. The solution was stirred for 15-20min. Later APS solution was added drop wise, till the solution turns black colour indicated the initiation of polymerization reaction [9]. The stirring was continued for another 6 hrs in order to complete the polymerization reaction. The precipitate so obtained was filtered and washed repeatedly with 1M HCl solution until filtrate becomes colorless and later washed with ethanol [10-11]. The synthesized nanocomposite of PANI-Cu_2Se was dried in an oven at $70^{\circ}C$ for 1hr.

IV. RESULTS AND DISCUSSION

A. X-ray Diffraction (XRD)

The crystal structures of the synthesized nanoparticles were investigated by powder X-ray diffraction (XRD). Fig. 1 & Fig. 2 shows the XRD pattern of PANI and doped PANI respectively. The XRD spectrum of pure PANI as shown in fig.1 has a peak at 20.06 and 25.18, indicates its crystalline nature. This characteristic peak of PANI is ascribed to the periodicity in parallel and perpendicular directions of the polymer chain. In fig. 2 the peaks observed for at 2θ angle at 22.68°, 31.74°, 46.18°, 52.71° and 58.92° confirms the formation of Copper selenide doped with PANI and it is crystalline in nature. The increase in ordering of polymer composite with the addition of Cu_2Se nanoparticles indicates that the structure of PANI is strongly influenced by the nanoparticles.

Hence, the orientation of conducting polymer nanocomposites is of much interest, due to more highly ordered polymer matrix it could display a conductive property as in metals. Presence of copper selenide peaks are observed in the PANI-Cu_2Se composite spectrum. This Cu_2Se peaks in the composite pattern confirms the formation of dispersed copper selenide in polyaniline.

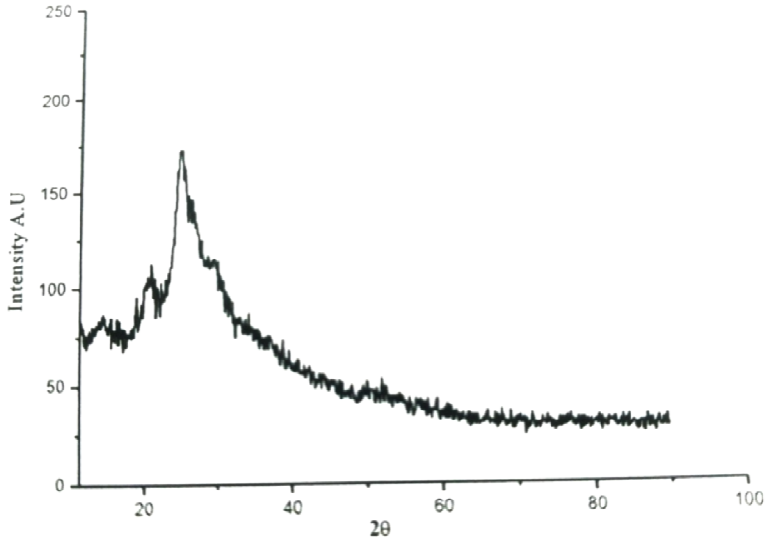

Fig. 1. X-ray diffraction images of PANI.

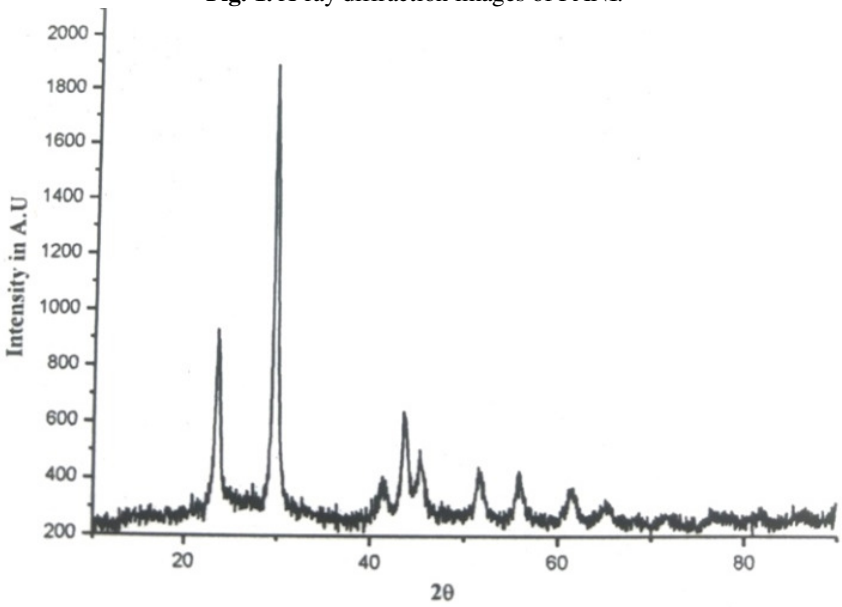

Fig. 2. X-ray diffraction images of Cu_2Se doped PANI.

B. Absorption Spectra

UV-Vis spectroscopy is a powerful technique to characterize interfacial interaction between the PANI and Cu_2Se doped PANI. Fig. 3 shows that three distinctive peaks of polyaniline at 329, 432, 913nm, which are attributed to π-π*, polaron-π* and π-polaron transition respectively.

It was found that all the three absorption peaks fig. 3 for PANI-Cu_2Se are shifted to the right compare to those of PANI film, indicates the red shift. The intensity of the PANI-Cu_2Se peak at 328 and 912nm is decreased significantly. The red shift of the polaron peak of the composite suggested that the polymer chains are existed in more expanded coil like conformation. The observed red shift in the composite indicates the insertion of nanoparticles-Cu_2Se to polymer chain.

The doping of nanoparticles with the polyaniline leads to an interaction at the interface of polyanilline and nanoparticles.

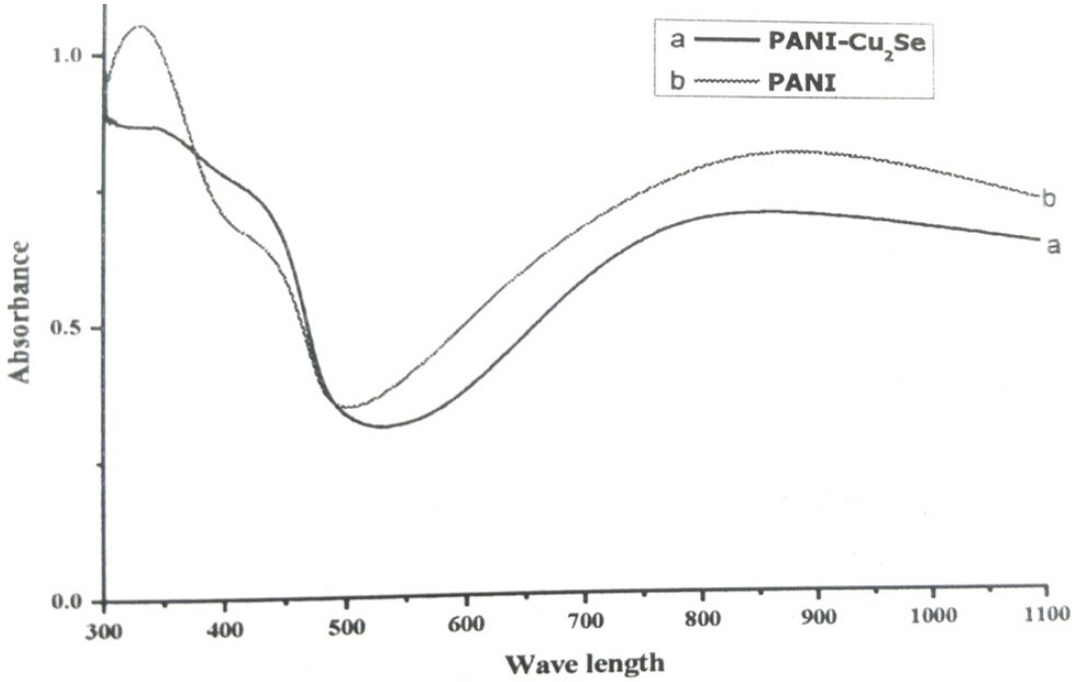

Fig. 3. UV-Visible absorption spectra of (a) PANI-Cu_2Se (b) PANI.

V. CONCLUSION

PANI/Cu_2Se nanocomposite was synthesized successfully by in situ polymerization through a simple and eco friendly technique. The XRD pattern indicates that PANI/Cu_2Se nanocomposite has an orderly arrangement of the polymer chain, whereas synthesized PANI is slightly crystalline in nature. UV–Visible spectroscopy also supports the formation of a nanocomposite and the also composite material shows red shift. Based on its optical properties and it may be used as a multifunctional material for nanoelectronic devices.

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REFERENCES

[1]. Luk. C. M, Chen B. L, Teng K. S, Tang L. B,.and Lau S. P. (2014). *Journal Article J. Mater. Chem.* C, Vol. **2**, PP.4526 - 4532.

[2]. R. Ratheesh and K. Viswanathan, (2014). *IOSR Journal of Applied Physics* (IOSR-JAP) 2278-4861. Volume **6**, Issue 1 Ver. II PP 01-09.

[3]. Qian Cheng, Jie Tang, Norio Shinya, Lu-Chang Qin. (2013). *Journal of Power Sources,* **241** .PP 423-428.

[4]. H. Chen, G. Zhao, Y.Liu, (2013). Low-temperature solution synthesis of CuO nanorods with thin diameter, *Materials Letters,* Vol. **93**, 60-63.

[5]. M. Wan, D. Jin, R. Feng, L. Si, M. Xia Gao, L. Yue, (2011). Pillow-shaped porous CuO as anode material for lithium-ion batteries, *Inorganic Chemistry communications*, Vol. **14**, 38-41.

[6]. Ankit Gupta and Mahendra Kumar (2015). *Paripex-Indian Journal of Research,* ISSN NO. 2250-1991, Volume: **4**, Issue: 9, pp-332-334.

[7]. Heilman, A, (2003). Polymer Films with Embedded Metal Nanoparticles, Springer, New York.

[8]. J. B. M. Krishna, A. Saha, G. S. Okram, A. Soni, S. Purakayastha and B Ghosh, (2009). *J. Phys. D: Appl. Phys.,* **42**, 095404.

[9]. Ankit Gupta and Mahendra Kumar (2015). *Paripex-Indian Journal of Research*, ISSN NO. 2250-1991, Vol. **4**, Issue: 9, pp-353-355.

[10]. Zhang, L. Peng, H. Sui, J. Soeller, C. Kilmarthin, P. and Sejdic, J. (2009). *J. Phys. Chem., C*, **113**, 9128.

[11]. Liu, W.; Kumar, J.; Tripathy S. Langmuir 2002, **18**, 9696–9704.