International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 3 Volume No.7 May - June – 2023
DOI:10.46647/ijetms.2023.v07i04.024 ISSN: 2581-4621

XRD Analysis of Polyaniline Thin Films Doped with Potassium Bromide and Picric Acid

Pradeep Kumar[1], Nempal Singh[2]
[1,2]School of Applied Sciences, Dept. of Physics, Shri Venkateshwara University, Gajraula, Amroha, (UP) INDIA
Orcid id: 0000-0002-6271-5007

ABSTRACT
The unique properties of conducting polymers not only provide great scope for their applications but also have led to the development of new models to explain their observed properties. Polyaniline has been the oldest among all the conducting polymers. Polyaniline has rapidly become the subject of considerable interest for physicists, chemists and material scientists. In this paper we have carried out the X-Ray Diffractional analysis of Polyaniline thin films doped with different concentrations (15% & 30%) of the dopants like Potassium Bromide and Picric Acid. The films has been prepared by using Vacuum Evaporation Technique and then characterized for XRD studies by using the X-Ray Diffractometer. The XRD studies reveals that the crystallinity of the doped polyaniline thin films has been increased with the increased doping concentration of the above said dopants which ensures its applications in the optoelectronic device technology.
Keywords: Polyaniline (PANI), X Ray Diffraction, Doping

I. INTRODUCTION

Polyanline is one of the oldest of conducting polymers and amongst the various conducting polymers Polyaniline (PANI) has rapidly become the subject of considerable interest for physicists, chemists and material scientists [1]. The unique properties of conducting polymers not only provide great scope for their applications but also have led to the development of new models to explain their observed properties, particularly various mechanisms of charge transport (Kaiser et al 1995, 1997) [2-3]. Among different conducting polymers, polyaniline are the most extensively studied material (Kumar et al 1996) [4-5]. However, when they are taken in the composite form their electrical as well as dielectric properties are altered from those of basic materials. A number of groups have reported studies on the electrical conductivity and dielectric properties of composites of a variety of conducting polymers (Yoon et al 1995, Yang et al 1996, Gangopadhay et al 2001, Murugesan et al 2003) [6-9]. It has been shown that the conductivity of these heterogeneous system depends on a number of factors such as the concentration of conducting fillers, their shape, size, orientation and interaction between filler molecules and host matrix (Kryszewaski 1991, Brosseau et al 2001[10-11]. The geometrical shape of the dispersant governs the ability of conductive network formation which results in the large increase in the conductivity (Troung et al 1994) [12].
Conductive polymers generally exhibit poor electrical conductivity ($\sigma \leq 10^{-12}$ S/cm) in the virgin state and behave as insulators. These virgin polymers need to be treated with a suitable oxidizing or reducing agents to remarkably enhance their conductivities to the metallic region [13]. This phenomenon has been termed as "doping". Doping can be simply regarded as the insertion or ejection of electrons. The electrical, magnetic, electronic, structural and optical properties of the polymer get dramatically changed because of this doping process [14-15]. Doping of polymeric semiconductors is different from that in inorganic or conventional semiconductors. Inorganic semiconductors have three dimensional crystal lattice and on incorporation of specific dopant, n-type or p-type in ppm level, the lattice becomes only highly distorted.

DOI:10.46647/ijetms.2023.v07i04.024 ISSN: 2581-4621

The dopant so added is distributed along the specific crystal orientations in particular sites on repetitive basis. Whereas, doping of conducting polymer involves randon dispersion or aggregation of dopants in molar concentrations in the disordered structure of entangled chains and fibrils. The dopant concentrations may be as high as 50%. The addition of the dopants in the quasi 1- dimensional polymer material remarkably disturbs the order of the chain which in turn leads into the re-organisation of the polymeric material. Since doping is a reversible process due to which it can produce the original polymer either with small or no degradation of the polymeric material. Both doping and undoping process, involving dopant counter ions which stabilize the doped state, may be carried out chemically or electrochemically. Electrons are generated in the conduction band and holes are generated in the valence band by the doping of inorganic semiconductors.
In this paper we have reported the X-Ray Diffraction studies of Polyaniline thin films doped with different concentrations (15% and 30%) of the dopants like Potassium Bromide and Picric acid.

2. EXPERIMENTAL DETAILS

Sample Preparation

The structural property of films mainly depends upon deposition technique. Both science and technological, applications have been responsible for development of thin film technology. In the present work we have used vacuum deposition technique for the preparation of the samples.
KBr & $C_6H_3N_3O_7$ (Picric Acid), has been purchased from CDH company of chemicals with purity 99.9% and polyaniline was prepared by chemical method and obtained in powdered form. Doping of KBr & $C_6H_3N_3O_7$ with polyaniline according to stoichiometry (15% and 30% wt.) and the resultant solution of each (KBr & Picric acid) was stirred for 60 min and poured into 200 ml of 5-10% NaOH solution. The precipitate obtained was filtered, washed and dried. This powder was used for preparation of polymeric films by evaporation on glass substrate sufficiently at very high vacuum of the order of 10^{-6} torr. Thus the KBr and Picric acid doped Polyaniline thin films are formed. After doping thin film of doped polyaniline were prepared.

XRD Analysis of Pure and Doped Polyaniline

XRD is a very useful technique for analyzing the structural characteristics of solids as well as in thin film form. This is the most convenient and easiest method to investigate the nature (crystalline, polycrystalline or amorphous) of a material. X-ray diffraction of undoped polyaniline, KBr & Picric Acid polyaniline has been characterized with the help of X-ray diffractometer at room temperature. This diffractogram was analyzed to obtain crystallographic information. The copper target was used as a source of Cu-Kα radiation with 1.5406 Aº. The scanning angle (2 θ) is in the range of 20º - 80º.
The XRD pattern of pure polyaniline is shown in figure 1. It has been reported that the crystallinity of polyaniline sample depends on the conditions set during the synthesis of the polymer. The XRD pattern of synthesized polyaniline with single broad peak indicates that the synthesized polyaniline is amorphous. The reported value for this amorphous peak is at 2 θ ~25.92 which is a characteristic peak of polyaniline.
Figure 2 shows XRD of 15% KBr doped polyaniline and it is clear from XRD pattern that various peaks appear as shown in the figure with different (hkl) values, which shows crystalline nature of the material. Figure 3 shows XRD of 30% KBr doped polyaniline with 2θ and d-spacing have been observed at 2θ ~ 25º, (d=3.56), hkl (101), 2θ ~ 30.77 (d=2.90), (hkl) (111), 2θ ~ 38.06, (d=2.36), (hkl) (210), 2θ ~ 42.520, (d=2.1), (hkl) (121), 2θ ~ 45º (d=2.01), (hkl) (211), 2θ ~ 51.799 (d=1.76), (hkl) (202) and 2θ ~ 72.117º, (d=1.30), (hkl) (321) shows better crystallinity.
The XRD of 15% picric acid doped polyaniline is shown in figure 4. The highest peak are 2θ~28.085, (d=3.17), (hkl) (200) and 2θ ~ 33.465 (d=2.67), (hkl) (211) from the XRD pattern, it is clear that the nature of the film is crystalline. From figure 5 it is clear that the crystallinity of the film increases after doping 30% picric acid.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 3 Volume No.7 May - June – 2023
DOI:10.46647/ijetms.2023.v07i04.024 ISSN: 2581-4621

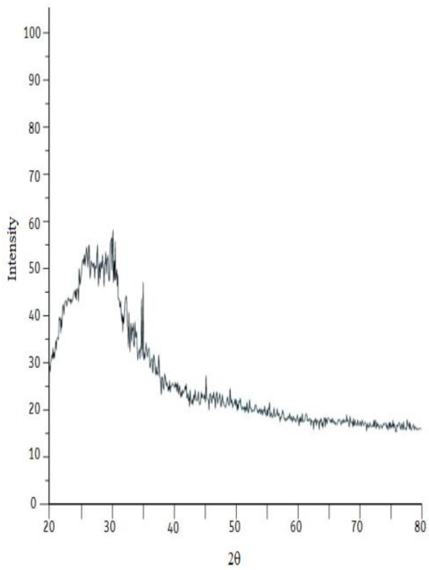

Fig. 1: XRD of PANI

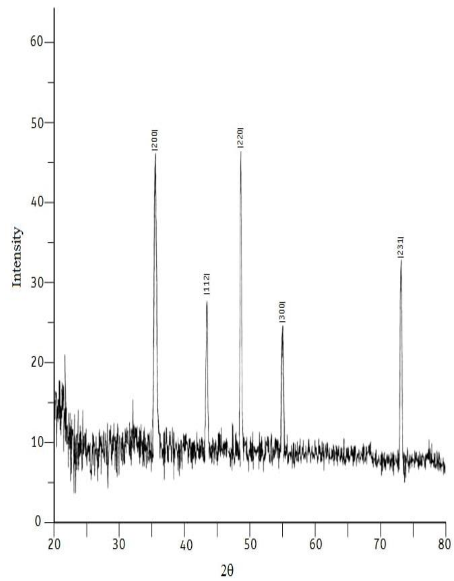

Fig. 2: XRD of 15% KBr doped PANI

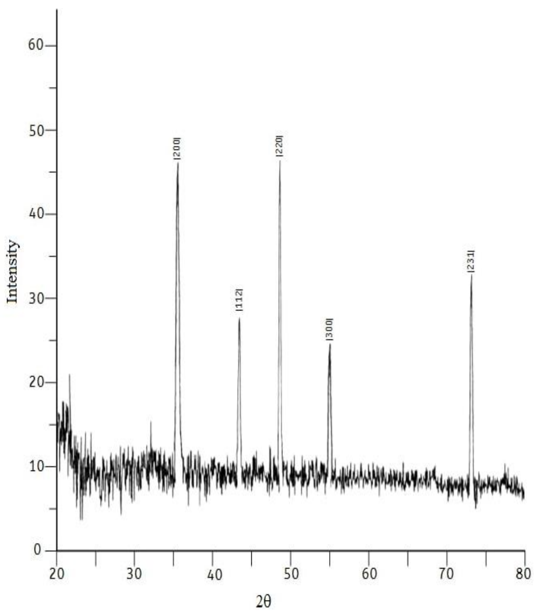

Fig. 3: XRD of 30% KBr doped PANI

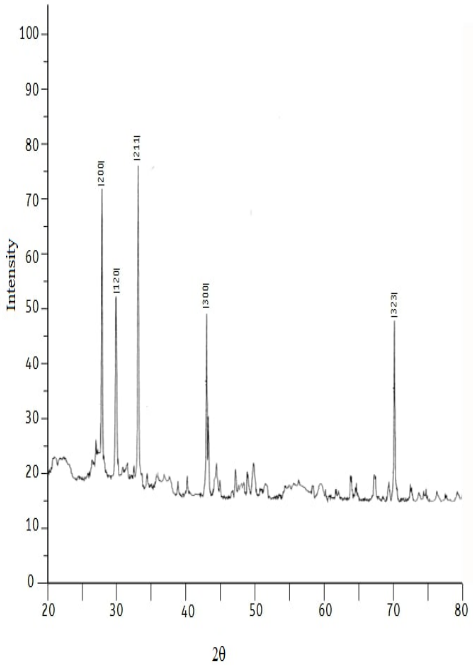

Fig 4: XRD of 15% Picric Acid doped PANI

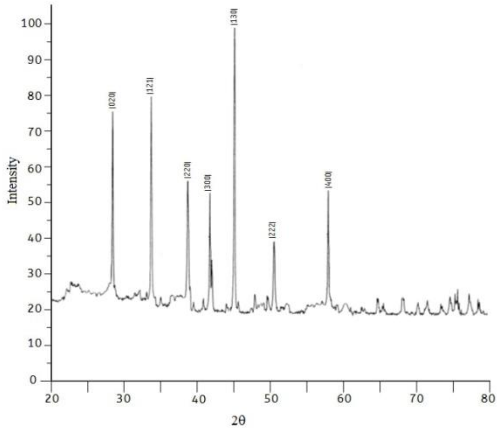

Fig 5: XRD of 30% Picric Acid doped PANI

DOI:10.46647/ijetms.2023.v07i04.024 ISSN: 2581-4621

RESULTS & DISCUSSION

This diffractogram was analyzed to obtain crystallographic information of the prepared samples of pure polyaniline and PANI film doped with different concentrations of Potassium Bromide and Picric acid. From the XRD pattern of pure polyaniline it has been reported that the crystallinity of polyaniline sample depends on the conditions set during the synthesis of the polymer. The XRD pattern of synthesized polyaniline with single broad peak indicates that the synthesized polyaniline is amorphous. However, the XRD of PANI doped with KBr and Picric Acid in this composition is not much reported in the literature. But our studies reveal that the crystallinity of the films has been increased with the increased doping concentration of the above said dopants which ensures its use in the optoelectronic devices.

REFERENCES

1. Vineet Bansal, Hema Bhandari & S.K.Dhawan , Indian Journal of Pure & Applied Physics Vol. 47, 2019, PP- 667-673.
2. Kaiser R.I., and Suits A.G., Rev. Sci. Instrum., 66, 1995, 5405.
3. Kaiser R.I., Stranges D., Bevsek H.M., Lee Y.T., and Suits A.G., J. Chem.Phys., 106, 1997, 4945.
4. Pravin T, M. Subramanian, R. Ranjith, Clarifying the phenomenon of Ultrasonic Assisted Electric discharge machining, “Journal of the Indian Chemical Society”, Volume 99, Issue 10, 2022, 100705, ISSN 0019-4522, Doi: 10.1016/j.jics.2022.100705
5. R. Devi Priya, R. Sivaraj, Ajith Abraham, T. Pravin, P. Sivasankar and N. Anitha. "MultiObjective Particle Swarm Optimization Based Preprocessing of Multi-Class Extremely Imbalanced Datasets". International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems Vol. 30, No. 05, pp. 735-755 (2022). Doi: 10.1142/S0218488522500209
6. Vo Ngoc Mai Anh; Hoang Kim Ngoc Anh; Vo Nhat Huy; Huynh Gia Huy; Minh Ly. "Improve Productivity and Quality Using Lean Six Sigma: A Case Study". International Research Journal on Advanced Science Hub, 5, 03, 2023, 71-83. doi: 10.47392/irjash.2023.016
7. Swathi Buragadda; Siva Kalyani Pendum V P; Dulla Krishna Kavya; Shaik Shaheda Khanam. "Multi Disease Classification System Based on Symptoms using The Blended Approach". International Research Journal on Advanced Science Hub, 5, 03, 2023, 84-90. doi: 10.47392/irjash.2023.017
8. Susanta Saha; Sohini Mondal. "An in-depth analysis of the Entertainment Preferences before and after Covid-19 among Engineering Students of West Bengal". International Research Journal on Advanced Science Hub, 5, 03, 2023, 91-102. doi: 10.47392/irjash.2023.018
9. Ayush Kumar Bar; Avijit Kumar Chaudhuri. "Emotica.AI - A Customer feedback system using AI". International Research Journal on Advanced Science Hub, 5, 03, 2023, 103-110. doi: 10.47392/irjash.2023.019
10. Rajarshi Samaddar; Aikyam Ghosh; Sounak Dey Sarkar; Mainak Das; Avijit Chakrabarty. "IoT & Cloud-based Smart Attendance Management System using RFID". International Research Journal on Advanced Science Hub, 5, 03, 2023, 111-118. doi: 10.47392/irjash.2023.020
11. T. Pravin, C. Somu, R. Rajavel, M. Subramanian, P. Prince Reynold, Integrated Taguchi cum grey relational experimental analysis technique (GREAT) for optimization and material characterization of FSP surface composites on AA6061 aluminium alloys, Materials Today: Proceedings, Volume 33, Part 8, 2020, Pages 5156-5161, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.02.863.
12. Rajashekhar, V., Pravin, T., Thiruppathi, K.: A review on droplet deposition manufacturing a rapid prototyping technique. Int. J. Manuf. Technol. Manage. 33(5), 362–383 (2019) https://doi.org/10.1504/IJMTM.2019.103277
13. V.S. Rajashekhar; T. Pravin; K. Thiruppathi , “Control of a snake robot with 3R joint mechanism”, International Journal of Mechanisms and Robotic Systems (IJMRS), Vol. 4, No. 3, 2018. Doi: 10.1504/IJMRS.2018.10017186
14. Kumar N, Malhotra B D and Chandra S, J. Polym. Phys. Ed. (USA) 23, 1985, 57.

DOI:10.46647/ijetms.2023.v07i04.024 ISSN: 2581-4621

15. Mishra S.C.K, Chandra S., Electronic Applications of Semiconducting Polymers, Indian J. Chem., 33A, 1994, 583.
16. Yoon C O, Reghu M, Moses D, Cao Y and Heeger A J, Synth. Met. 26, 1995, 255.
17. Yang J, Hau J, Zhu W, Xum and Wa M, Synth. Met. 80, 2016, 203.
18. Gangopadhyay R, De A and Ghosh G Synth. Met. 123, 2010, 529.
19. Murugesan R and Subramanian E, Bull. Maton. Sci. 26, 2020, 529.
20. Kryszewaski M, Synth. Met. 105. 2018, 289.
21. Brosseau, Queffelec P and Talbot P, J. Appl. Phys. 189, 2019, 4532.
22. Troung V T, Codd A R and Forsyth M, J. Mater. Sci. 29, 2004, 4331.
23. A.M.Pharhad Hussain and A. Kumar.Poull.Mater.Sci. Vol. 26 No. 3, (April-2003), © Indian Academy of Sciences. pp. 329-334.
24. Jian Gong, Xiu CUI, Shou Guo WANG, Zhong Wei XIE Yu QU, Chinese Chemical Letters Vol.13, no.2, (2012) 123-124.
25. Pavan A C; Lakshmi S; M.T. Somashekara. "An Improved Method for Reconstruction and Enhancing Dark Images based on CLAHE". International Research Journal on Advanced Science Hub, 5, 02, 2023, 40-46. doi: 10.47392/irjash.2023.011
26. Subha S; Sathiaseelan J G R. "The Enhanced Anomaly Deduction Techniques for Detecting Redundant Data in IoT". International Research Journal on Advanced Science Hub, 5, 02, 2023, 47-54. doi: 10.47392/irjash.2023.012
27. Nguyen Kieu Viet Que; Nguyen Thi Mai Huong; Huynh Tam Hai; Vo Dang Nhat Huy; Le Dang Quynh Nhu; Minh Duc Ly. "Implement Industrial 4.0 into process improvement: A Case Study in Zero Defect Manufacturing". International Research Journal on Advanced Science Hub, 5, 02, 2023, 55-70. doi: 10.47392/irjash.2023.013
28. D.Patidar, N.Jain, N.S.Saxena, K.Sharma, and T.P.Sharma, Brazilian Journal of Physics, vol. 36, no. 4A, Dec. 2006 163-67.