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Study the optical properties of solid polymer electrolyte based on polyvinyl alcohol

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Abstract

Polyvinyl alcohols doped with different percentage of Ammonium fluoride were prepared by solution casting technique. The optical constants such as Absorption coefficient, transmission spectra, refractive index, extinction coefficient, optical band gap were investigated by using UV-Vis Double Beam spectrophotometer in the wavelength range (190-1100) nm. It was found that the energy band gaps are decrease with increase of salt concentration.

Keywords: Polyvinyl alcohol, UV-Vis spectrophotometer, optical band gap, optical properties

Introduction

Solid polymer electrolyte are proficiently significant due to their wide range application in solid state electrochemical devices like batteries, fuel cell, super capacitor, sensors etc. (1-4). In recent year researcher fascinated toward solid proton conductor due to their ease of handling low cost, high environment stability(5). Electrical and optical properties of polymer can be suitability modified by adding of salt. In present study, PVA has been chosen as polymer host due to their mechanical strength, excellent film-forming ability, dopant-depenent electrical and optical properties, low cost and high tensile strength (6-7). PVA is semicrystalline material and it contain hydroxyl group attach to methane carbon which can be source of hydrogen bounding. As per literature survey ammonium salt are very good proton donor (8-10). The polymer electrolyte based on polyvinyl alcohol based with ammonium fluoride has been studied by using UV-Vis Double Beam spectrophotometer.

Materials and methods

Films of Polyvinyl alcohol-Ammonium fluoride were prepared by solution casting method. The suitable amount of Polyvinyl alcohol (PVA) and Ammonium fluoride was dissolved separately in double distill water. These solution was mixed together and stirred well to get homogenous solution. These homogenous solutions were casted on glass plate. The whole assembly was placed in dust free-chamber and allowed to evaporate the solvent slowly in dry atmosphere at room temperature for 4-5 days. The thickness of the films was in the range (0.045-0.021) mm. It was determined

using micrometer at different places in each films and average was taken.

Optical properties

The basic principle behind the UV visible spectroscopic depend on the absorption of photons with energies greater than the band gap energy of carrier which undergoes transition from occupied state in valance band to unoccupied state in conduction band (11-12). The study of optical absorption gives information about band structure of solid. Generally there are two types of optical transition that occur at fundamental edge in solid like insulators/semiconductor such as (a) Direct band gap (b) indirect band gap semiconductor. The top of valance band and the bottom of the conduction band lies at the same zero crystal momentum (zero vector). If the bottom of conduction band does not correspond to zero crystal momentum, then it is called indirect band gap semiconductor. In indirect band gap semiconductor, the transition from valance band to conduction band should always be associated with a phonon of the right magnitude. Davis and Shalliday (13) reported that near fundamental band edge both direct and indirect transition occur can be determine by plotting $\alpha^{1/2}$ and α^2 as function of photon energy hυ.

The Thutupalli and Tomlin gave the relationship based on the analysis for direct and indirect band of semiconductors/insulator respectively

$(h\alpha\upsilon n)^2 = c(h\upsilon - E_{gd})$ ---------- (1)

$(h\alpha\upsilon n)^{1/2} = c(h\upsilon - E_{gi})$ ---------- (2)

Where hυ is the photon energy, E_{gd} is the direct band gap, E_{gi} is the indirect band gap, n is the refractive index, α is absorption coefficient and C_1, C_2 are constants.

The optical studies are carried out to determine optical constant such as absorption coefficient, extingtion coefficient, refractive index, optical band gap. The absorption coefficient was calculated from the absorbance using the relation

$I=I_o\exp(-\alpha x)$

Hence $\alpha = \frac{2.303}{x}\log\left(\frac{I}{I_o}\right) = \left(\frac{2.303}{x}\right)A$

Where x is the thickness of the sample under study. A is the absorbance coefficient.

The extingtion coefficient (K) of the film is calculated using equation

$K=\frac{\alpha\lambda}{4\pi}$

Where λis wavelength of incident light.

Results and discussion

Optical Absorbance Spectra

The optical absorbance spectra as a function of wavelength for prepared polymer composite has been recorded by double beam UV Vis spectrophotometer in the wavelength range (190-1100) nm. The optical absorbance against the wavelength range (190-490) nm of polyvinyl alcohol and polyvinyl alcohol with ammonium salt is shown in fig 1

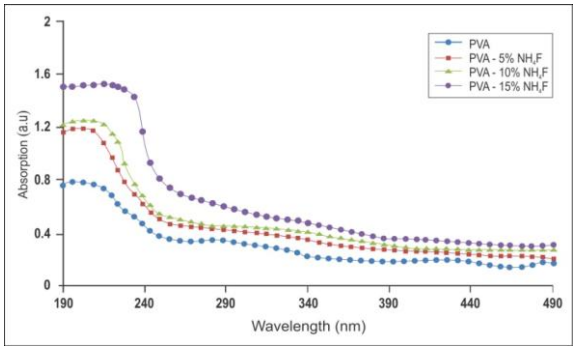

Figure 1

The absorbance shows a sharp increase in absorbance at the wavelength near the absorbance edge of the threshold wavelength. The energy corresponding to this region determine the band gap of the sample(12).

Extinction Coefficient

The Extinction coefficient against wavelength in the wavelength range (190-400) nm is shown in the fig 2.

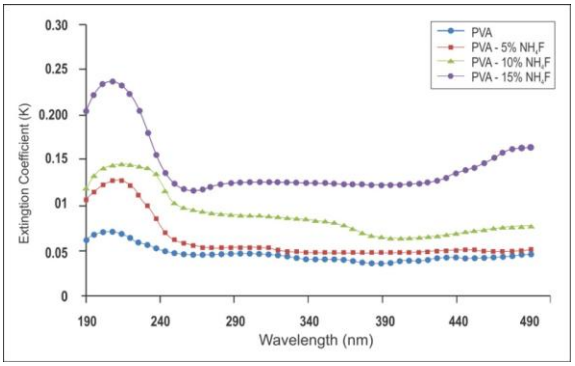

Figure 2

It is observed that composite films dissipate more photon energy than those of pure PVA for higher value of extinction coefficient.

Optical Band Gap

The optical band gap energies were evaluated from $(\alpha h\alpha)^2$ verse photon energy ($h\upsilon$) plot is as shown in fig 3.

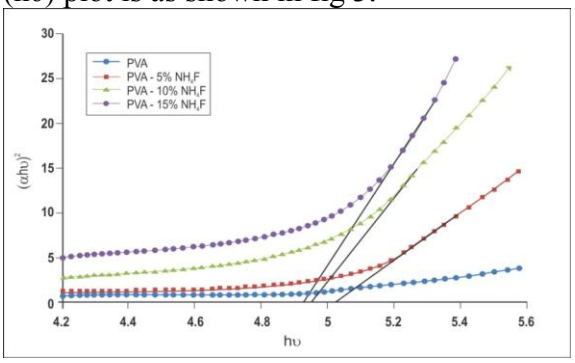

Figure 3

The allowed direct transition energy were determined by extrapolation the linear portion of the curves to zero absorption .The optical band gap decreases from 5.83 eV for pure PVA to 4.98 eV for NH_4F concentration increase up to 15%. The decrease in the optical band gap may be explained on the basis of the fact that the incorporation of small amount of dopant from charge transfer complex in the host matrix (16-17).these charge transfer provides conductivity by providing addition charges this result in decrease of the optical energy gap.

Conclusion

The solid polymer electrolyte based on PVA doped with different concentration of ammonium fluoride has been prepared using solution cast technique. The absorbance coefficient and extingtion coefficient are increasing with increase the concentration of ammonium fluoride. The optical band gap decreases from 5.83 eV for pure PVA to 4.98 eV for NH_4F concentration increase up to 15%. The optical band gap increases due to increase the number of mobile charge carrier into the host polymer.

References

1) Guinot S, Salmon E, Penneau J F.Fauvarque J.F, (1998) Electro-chim. Acta 43, 1163-1170.
2) Vassal N,Salmon E, Fauvarque J.F, (1999) J.Electrochem Soc. 146, 20-26.
3) Lawandowski A.Skorupska K, Malinska J, (2000) solid State Ionics 133, 265-271.
4) Mohamad A.A, Mohamed N.S, Alias Y, Arof A.K, (2002) J. Alloys Comp. 337, 208-213.
5) Khodary A.El, Oraby A. H,Abdenaby M.M, (2008) Journal of magnetism and magnetic material 320, 1739-1746.
6) Krumova M , lopaz D , Benavent R.,Mijangos C, Parena J. M, (2002) polymer 41,9265-9275.
7) Masuda K, Kaji H, Hori F (2002)J Polym Sci Part B,polym phy 38,1-7.
8) Billmeyer F, (1984) Jr text book of polymer science Wiley Singapore.
9) Chandra S, Hashim S A, Prasad G., (1990) Solid State Ionic 40-41, 651-654.
10) Kumar M, Sekhon S. S, (2002) Eur polym J 38, 1297-1304
11) Murri R ,Schiavulli L, Pinto N, Ligonzo T, (1992) Journal of non crystalline solid 139, 60-66.
12) Urbach F (1953) physics review 92, 1354.
13) Devis S, Shalliday T S, (1960) physics review 118, 1020

14) Thutupalli G. M, Tomlin S. G, (1976) J Phys D App Phys 9, 1639-1646.
15) Das R, Panday S. (2011) International Journal of Material Science 1, 35-40.
16) Devi U, Sharma A. K, Rao V. N, (2002) Material letter 56, 167-174.
17) Raja V, Sharma A. K, Rao V. N, (2003) Material letter 57, 4678-4683.