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Study of ion transport behavior in CeO_2 dispersed fast ion conducting composite electrolyte system

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Abstract : Ionic transport studies on new silver ion conducting two-phase composite electrolyte system: (1–x)[0.75AgI:0. 25AgCl]: $xCeO_2$, where $0.1 \leq x \leq 0.5$ in mol. wt. (%), are reported. CeO_2 has been used as inert and insulating second phase dispersoid, while 'quenched/annealed [0.75AgI:0. 25AgCl] mixed system/solid solution' has been used as first phase host matrix salt in place of the traditional host AgI. Agrawal and coworkers [J. Mater. Sci. 29 3673 (1994); J. Non-Cryst. Solids 181 110 (1995)] have already established that the alternate host salt yields superior glass and composite electrolyte systems. Various preparation routes have been attempted for different soaking times. The composition- dependent conductivity studies revealed that the composition: 0.85[0.75AgI:0.25AgCl]: 0.15 CeO_2 exhibited highest room temperature conductivity σ ~1.2 x 10^{-3} Scm^{-1}. This has been referred to as Optimum Conducting Composition (OCC). An enhancement of approximately an order of magnitude as compared to that of annealed host salt has been achieved in OCC. Ionic mobility (μ) and mobile ion concentration (n) measurements have been carried out to identify the reason for conductivity enhancement in OCC. The transference number (t_{ion}) measurement clearly indicated that OCC is a pure ionic system with Ag^+ ions as sole charge carriers.

Keywords : Composite electrolyte, ionic conductivity, mobility, transference number, drifts velocity

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Growth and DC conductivity studies in $MnSeO_4.2H_2O$ single crystal

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Abstract : DC electrical conductivity measurements are carried out in manganese selenate dihydrate ($MnSeO_4.2H_2O$) single crystal. The crystal has been grown at 303K. Conductivity measurements are taken along a-axis in the temperature region of 305K-353K. Conductivity anomalies are observed around 320K and 336K. The strong anomaly around 336K can be attributed to thermal dehydration of the crystal. Activation energy is calculated for both heating and cooling runs.

Keywords : DC conductivity, manganese selenate dihydrate, single crystal, phase transition

PACS No. : 81.10.Dn

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Structural analysis of lithium nickel vanadate Li_xNiVO_4(x=0.8, 1.0, 1.2)

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Abstract : In recent years, inverse spinel vanadates such as $LiNiVO_4$ and $LiCoVO_4$ have been reported as new systems for cathode materials for secondary lithium batteries because of their high voltage up to 4.8 V. In the present study the compounds Li_xNiVO_4 (x = 0.8, 1.0, 1.2) have been prepared by solid state reaction method. The XRD analysis of the three samples shows that there is no prominent structural change on addition of Li. The XRD patterns are found to be consistent with the JCPDS values. The vibrational analysis of the compounds have been studied using FTIR and Raman technique. A new peak at 1039 cm^{-1} has been observed for $Li_{1.2}NiVO_4$ in the FTIR analysis indicating the presence of Li^+-O-V bond interactions. Raman analysis indicates the inverse spinel structure of the three samples.

Keywords : Lithium nickel vanadate, inverse spinel, XRD, SEM, FTIR and Raman analysis

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AC conductivity and dielectric studies of $K_3Na\ (SeO_4)_2$ single crystal in the high temperature region

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Abstract : Study of ac electrical conductivity and dielectric properties of Tripottasium sodium diselinate $K_3Na\ (SeO_4)_2$ (or KNSe) is reported. Earlier studies of phase transition in this crystal showed successive phase transitions at 334K, 346K, 730K and 758K. In this paper, we report the ac electrical conductivity and dielectric studies in the temperature region 303K – 430K along c – axis. An anomaly in conductivity was obtained around 345K and another weak anomaly at 334K. These can be attributed as due to phase transitions in this crystal. A strong anomaly has also been observed at around 379K and 392K for the first time. This can be due to a newly observed phase transition in the crystal. Frequency-dependant dielectric spectra and temperature- dependent dielectric spectra have also been studied.

Keywords : Tripotassium sodium diselinate, AC conductivity, phase transition, single crystal.

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Proton conductors and their application

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Abstract : There has been a great deal of scientific and technological interest in developing improved battery systems for use in portable electronic devices, backup power systems to electric vehicles. Solid-state protonic conductors have also extensively been used in the following electrochemical devices (i) gas sensors, (ii) electro-chromic displays, and (iii) fuel cells. However, relatively less attention has been paid towards their application from solid state battery point of view. Compared to others like lithium and silver solid-state batteries, these are very simple to fabricate and economic. A solid proton conductor of crystalline / amorphous form allows the passage of electrical current through the bulk material exclusively by movement of protons, H^+. The electrochemical transfer of H_2 from one electrode to the other has taken place due to applied potential difference to the electrodes when proton conductor is placed in between the two noble metals / hydrogen. The H^+, H_3O^+, OH^- or NH_4^+ have been the known conducting species of this class. Some of the reported good proton conductors have been acidic and basic hydrates like, HUP, HUAS, PSA, PMA, etc. In general, the charge transfer in solid by motion of protons has been the major problem in the field of proton conduction. So, it has become all the more necessary to understand a clear-cut difference between electron, ion and proton conduction, and also to obtain convincing proof of charge transfer by proton species. In this paper, a brief work on proton conductors and solid-state battery is presented.

Keywords : Solid-state proton conductors, protonic secondary battery, cathode, internal resistance.

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Development of intercalating γ-MnO_2 for protonic solid-state battery

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Abstract : An intercalating γ-MnO_2 was synthesized and characterized as a cathode material for protonic solid-state battery by chemical route. Manganese hydroxide on oxidation gets converted into highly electroactive manganese dioxide, which can be utilized in dry cells. The actual performance of the synthesized material as cathode in protonic solid-state batteries was tested by fabricating electrochemical cell using composite of zinc and electrolyte as an anode. The proton conducting $Na_2S_2O_3.5H_2O$ was selected as a solid electrolyte. The synthesized cathode material compliments well for the intercalation of protons. The results are well supported by the chemical bond model for intercalation.

Keywords : Manganese dioxide, intercalation, solid-state protonic battery.

PACS Nos. : 66.30.-h, 61.72.-y, 82.45.-h

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A novel liquid-solid lead-acid secondary battery: study of charge-discharge behavior

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Abstract : Lead-acid secondary batteries are used traditionally worldwide as power sources in number of electrical utilities. These batteries are bulky in size and less rugged, hence, pose several handling problems. Recently, a novel prototype lead-acid battery based on liquid-solid composite structure, has been designed which is a miniature version and can withstand several charge-discharge cyclability. This paper reports the fabrication and discharge characteristic studies on these secondary batteries. The results presented here are based on some preliminary measurements. An open circuit voltage (OCV) ~ 1.9V has been obtained which is very close to the OCV value (~ 2V) of the conventional lead-acid battery. The cell performance has been studied under different load conditions and for seven charge-discharge cycles.

Keywords : Lead-acid battery, charge-discharge behavior, liquid-solid composite

PACS Nos. : 07.50.-e, 82.47.-a, 77.84.Lf

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Solid state proton conducting secondary battery at room temperature

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Abstract : Using P_2O_5, SiO_2 and Al_2O_3, a proton conducting electrolyte, zinc anode and with three different cathodes MnO_2, PbO_2 and V_2O_5 , a few electrochemical cells were fabricated. The open circuit voltage (OCV) and short circuit current (SCC) of the cells are found to be 1.82, 2.23 and 1.91 V and 3, 2.1 and 0.8 mA, respectively. The performance of MnO_2 cathode is better than that of other two materials viz. PbO_2 and V_2O_5. The materials used in the cells are environment friendly and no special atmospheric conditions are required for cell fabrication as in case of lithium cells.

Keywords : Room temperature proton conductors, solid-state battery, cathode.

PACS Nos. : 66.30.-h, 61.72.-y, 82.45.-h

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Citric acid induced improved homogeneity of CeO_2 coatings for electrochromic device applications

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Abstract : An alcohol based sol-gel process involving cerium chloride heptahydrate and citric acid in different mole ratios has been employed for the deposition of CeO_2 coatings. The structural, electrochemical, and optical properties of the coatings have been investigated by a wide range of characterization techniques. The homogeneity induced in the films upon an addition of the stabilizer to the precursor sol, has been accompanied by a simultaneous reduction in the ion storage capacity (ISC) of the films. The emphasis is on the use of optimum content of the citric acid such that the films are suitable in terms of transparency as well as uniformity characteristics and also exhibit good electrochemical response. A higher proportion of citric acid also resulted in a reduced crystallite size of the cerianite phase. The effect of the CeO_2 coatings on the switching kinetics of the tungsten oxide (WO_3) films revealed a rise in the colouration time with the diminished crystallite size of CeO_2 nanograins in consequence of the enhanced content of citric acid employed for the deposition of the CeO_2 films.

Keywords : Sol-Gel, spin coating, CeO_2, passive counter electrode, electrochromism

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Performance of electrochemical CO_2 gas sensor with NASICON dispersed in a binary solid electrolyte system

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Abstract : The potentiometric CO_2 sensor fabricated using NASICON dispersed in 70 Li_2CO_3 : 30 $BaCO_3$ as solid electrolyte and TiO_2-$Na_2Ti_6O_{13}$ composite as reference electrode. The sensor found to respond for CO_2 gas concentration and temperature range of 200-2000 ppm and 400-550°C, respectively. The sputtered palladium on the electrolyte side with test gas follows the reaction $CO_2+1/2O_2 + 2Li^+ + 2e^- \rightarrow Li_2CO_3$. The cell response was Nernstian showing nearly two electron reactions. The long-term stability of the sensor was good with the response time about 80 seconds.

Keywords : CO_2 gas, sensor, NASICON, solid electrolyte.

PACS Nos. : 66.30.-h, 61.72.-y, 82.45.-h

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Thermal investigations on mechanically milled and melt-quenched superionic glasses using differential scanning calorimetry

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Abstract : Differential scanning calorimetry (DSC) has been successfully used to identify important differences between mechanically milled (MM) and melt quenched (MQ) $AgI-Ag_2O-M_xO_y$ (M_xO_y = CrO_3, MoO_3 and V_2O_5) superionic glasses. The MQ as well as MM samples exhibit glass transition (T_g) and amorphous $\Rightarrow$ crystalline transition (T_c) temperatures. T_g as well as T_c are found to increase monotonically with heating rate and the crystallization and glass transition kinetics is studied in the MM and MQ samples. The activation energies associated with the crystallization (E_c) and structural relaxation (E_s) at T_g are obtained. The enthalpy and entropy changes (ΔH and ΔS, respectively) at the crystallization temperature are also obtained from the DSC thermograms. An analysis based on these quantities reveals interesting results. Finally, the fundamental differences in the basic characteristics of MM and MQ samples have been pointed out.

Keywords : Differential scanning calorimetry, superionic glasses

PACS Nos. : 61.43.Fs, 66.10.Ed, 65.60.+a

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Effect of TiO_2 addition on the durability of sol-gel derived WO_3 films

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Abstract : Tungsten oxide (WO_3) films are of practical importance for electrochromic device (ECD) technology. Amorphous WO_3 films show very good electrochromic properties and can be made by a variety of techniques. For large area application of ECDs like smart windows, sol-gel is the best processing technique for its many known advantages. Films (OX-APTA) deposited using ethanolic solution of acetylated peroxotungstic acid (APTA) with oxalic acid as a chemical additive, exhibit good optical modulation and fast kinetics, the most desired properties for their use as primary electrochromic electrodes in ECDs . However, the practical viability of ECDs demands extended durability. This paper presents preliminary results of attempt made towards enhancing durability of OX-APTA films by adding poly peroxotitanic acid (PPTA) in different proportions to the deposition solution so as to give Ti content varying between 5 to 25 mol % .Spin coated films with and without Ti, after appropriate thermal treatment, have been subjected to cyclic voltammetry over a large number of cycles. The studies revealed that for optimum amount of Ti, films have three times better durability without affecting the optical modulation and kinetics of the mixed films.

Keywords : Electrochromic device, tungsten trioxide, titanium oxide, durability

PACS Nos. : 81.15Lm, 81.40Tv, 85.80.-b

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Transport property studies on a new silver ternary glassy electrolyte system : x [0.75AgI:0.25AgCl] : (1-x) [Ag_2O:V_2O_5]

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Abstract : Investigations on ion transport behavior in the newly synthesized silver ternary glassy electrolyte systems: x [0.75AgI : 0.25AgCl] : (1-x)[Ag_2O:V_2O_5], where 0.1< x <1 in molar weight fraction, are reported. These systems were prepared by roller quenching technique. An alternate host: 'a quenched [0.75AgI:0.25AgCl] mixed system/ solid solution', was used in place of the traditional host AgI. The alternate host has been reported to yield number of fast Ag^+ ion conducting glassy/ composite systems with superior electrolyte properties as compared to those prepared identically with AgI. The composition dependent conductivity studies at room temperature revealed that the composition: 0.8[0.75AgI:0.25AgCl]:0.2[Ag_2O:V_2O_5] has the highest conductivity (σ ~ 9 x 10^{-3} Scm^{-1} at 300K). This has been referred to as Optimum Conducting Composition (OCC). An enhancement of more than an order of magnitude in the conductivity has been achieved in OCC from that of the pure host with σ ~ 3.1 x 10^{-4} Scm^{-1} at 300K. The phase identification studies on OCC using XRD and DTA techniques confirmed the formation of the glassy phase. To identify the reason for conductivity increase in OCC, direct determination of ionic mobility (μ) has been carried out by Transient Ionic Current (TIC) technique. Subsequently, the mobile ion concentration (n) has been evaluated with the help of conductivity and mobility data. The temperature-dependent-conductivity measurements have been carried out on OCC to compute the activation energy (E_a) from 'log σ -1/T ' Arrhenius plot.

Keywords : Transport property, glassy composite

PACS Nos. : 74.25.Fy, 61.43.Fs, 81.05.Pj

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Electrical conductivity of $Li_2O : B_2O_3 : ZnO$ glasses

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Abstract : The study of electrical conductivity of 27.5 Li_2O : (72.5-x) B_2O_3 : x ZnO glass samples has been carried out. The results have been explained by dividing the temperature range into two regions. In region - I, there is a linear increase in conductivity with temperature for all the samples. The conductivity decreases with addition of ZnO . In region - II, it is observed that for all the samples, the conductivity suddenly increases, exhibits a plateau for certain temperature range and then decreases with further increase in temperature. The increase in conductivity has been attributed to nucleation and the subsequent decrease in conductivity to the crystallization of the glass samples.

Keywords : Lithium conducting glasses, electrical conductivity, nucleation and crystallization, glass transition temperature

PACS Nos. : 61.43.Fs, 64.70.Pf, 66.10.Ed, 81.10.Aj, 64.60.Qb

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Ion transport studies on a new silver ion conducting lead borate glass system: x[0.75AgI:0.25AgCl] : (1-x)[Ag_2O:(PbO:B_2O_3)]

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Abstract : Ion transport measurement have been carried out on newly synthesized silver- lead-borate glass system: x[0.75AgI:0.25AgCl] : (1-x)[Ag_2O:(PbO:B_2O_3)], where $0 \le x \le 1$ is in molar weight % ratio prepared by melt quench method in liquid nitrogen. The conventional host salt AgI has been replaced by an alternate compound: "quenched [0.75AgI:0.25AgCl] mixed system/solid solution" for synthesis of new glass system. Ionic conductivity (σ) as a function of 'x' has been carried out to find out "optimum conducting composition" (OCC). An enhancement in conductivity was observed at the composition: 0.8 [0.75 AgI : 0.25 AgCl] : 0.2 [Ag_2O : (PbO : B_2O_3)] exhibiting highest conductivity ($\sigma_{rt} \sim 2.0 \times 10^{-2}$ S/cm) at room temperature. Temperature dependence of conductivity has been reported on optimum conducting composition (OCC) for quenched glass system. Phase identification and thermal analysis studies were also performed using XRD and DSC respectively.

Keywords : Silver glasses, ion conducting glasses.

PACS Nos. : 66.30.Hs, 61.43.Fs, 66.10.Ed, 71.55.Jv

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Frequency response of the mechanochemically synthesized AgI-Ag_2O-B_2O_3 superionic glasses

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Abstract : The synthesis of $xAgI(1-x)[Ag_2O.B_2O_3]$ amorphous superionic conductors is done via mechanochemical synthesis route (for x = 0.5 and 0.7). Ionic conductivities of $3\times10^{-3}\Omega^{-1}cm^{-1}$ for x = 0.5 sample and $5\times10^{-3}\Omega^{-1}cm^{-1}$ for x = 0.7 sample at room temperature, are observed, which are higher than those of the melt quenched glassy samples. Impedance plots (Nyquist plots) are found to be depressed semicircles with a tail at low frequency end. The corresponding equivalent circuit is postulated and each circuit element is related to a physical process. The ac conductivity $\sigma\ \omega$ is analyzed in view of the universal dynamic response (UDR), $\sigma\ \omega = \sigma + \omega$ (Bode Plots). A unique feature of the mechnochemically synthesized glasses is that their σ vs. 1/T behavior exhibits two distinct regions with different activation energies. The activation energy for dc conductivity (E_{dc}) and that for ac conductivity (E_{ac}) and the frequency exponent n are found to satisfy the UDR–relation, $E_{ac} = (1-n)E_{dc}$ in the lower temperature regime. In the high temperature region, however, this correlation could not be established due to lack of σ data over the available frequency domain.

Keywords : Frequency response, mechanochemical synthesis, superionic glasses, ball milling.

PACS Nos. : 66.30.Dn, 72.80.Ng

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Structural and transport studies on rapidly quenched PbI_2 -Ag_2O – WO_3 composites

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Abstract : Superionic transport in a series of compositions of the mixed system $(PbI_2)_x – (Ag_2O – WO_3)_{100–x}$, $(5 \leq x \leq 50)$ has been investigated by employing structural, thermal and electrical characterization techniques. The structural characterization carried out by X-ray powder diffraction method has indicated the formation of phases such as AgI, Ag_2WO_4 and $PbWO_4$ along with some new phases for relatively higher concentrations of PbI_2. Differential scanning calorimetric studies performed on the various samples have confirmed the presence of AgI in almost all the compositions of the mixed system. In addition, the detailed complex impedance measurements have suggested that the electrical conductivities are of the order of 10^{-5}–10^{-3} Scm^{-1} at 300K. The transport number data for Ag^+ ions determined by the emf method are found to be above 0.94 for all the compositions under investigation. The best conducting composition has been identified as the typical composition having 25 mol% PbI_2 which exhibited a silver ionic conductivity of 7.4×10^{-3} Scm^{-1} at room temperature.

Keywords : Superionic conductor, X-ray diffraction, differential scanning calorimetry

PACS Nos. : 72.80.Tm ; 84.32.Ff ; 61.10.Nz

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Can lithium ion conducting gels have higher conductivity than the corresponding liquid electrolytes?

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Abstract : The addition of polymer increases the viscosity of electrolytes, which reduces ionic mobility and as a result, conductivity decreases and generally, σ(gel) < σ(liquid) is observed. However, recent results from our group show that the addition of polymer can also result in an increase in conductivity alongwith an increase in viscosity and σ(gel) > σ(liquid) has been observed for lithium ion conducting polymer gel electrolytes. The increase in conductivity has been found to depend upon the dielectric constant of the solvent, concentration of salt and molecular weight of the polymer used.

Keywords : Polymer gel electrolyte, lithium salt, viscosity, dielectric constant.

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Effect of different plasticizers on the conductivity behaviour of polymer electrolytes containing NH_4PF_6

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Abstract : Polymer electrolytes obtained by the complexation of ammonium hexafluorophosphate (NH_4PF_6) with polyethylene oxide (PEO) show conductivity of the order of 10^{-7} S/cm at 25°C. The addition of propylene carbonate (PC), diethyl carbonate (DEC) and dimethyl carbonate (DMC) as plasticizer results in an increase in conductivity which depends upon the concentration of plasticizer, dielectric constant (ε) of plasticizer and the concentration of salt in the polymer electrolytes. The conductivity increases by two order of magnitude and maximum conductivity of 1.4 x 10^{-5} S/cm has been obtained for electrolytes containing PC. The increase in conductivity has been explained to be due to the dissociation of ion aggregates and an increase in amorphous content with the addition of plasticizers.

Keywords : Polymer electrolyte, plasticizers, dielectric constant

PACS Nos. : 82.45.Wx, 77.22.Ch

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Study on steady-state dark I-V characteristics of phenosafranin dye based solid-state thin film photoelectrochemical cell and calculation of band gap energy

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Abstract : The steady–state dark I-V characteristics of phenosafranin dye-doped solid state polymer photoelectrochemical cell (PEC) has been studied here. The cell contains a blend made of the dye dispersed in polyvinyl alcohol (PVA), polyethelene oxide (PEO) complexed with lithium perchlorate ($LiClO_4$) ionic salt as solid electrolyte with ethylene carbonate (EC) and propylene carbonate (PC) as plasticizers.

A thin film (~200 nm) of the above blend is sandwitched between a transparent indium-tin-oxide coated glass plate and an aluminium plate which act as two contact electrodes. In the present study, we have concentrated on the steady state dark I-V characteristics of the device. The trap assisted charge carrier transport model is used to satisfactorily describe I-V characteristics.

Keywords : Photoelectrochemical cell, trap assisted charge carrier, phenosafranin, thin film.

PACS Nos. : 73.61.Ph , 82.47.Jk

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Effect of 160 MeV Ne-ion irradiation on polymer salt complex films containing laponite

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Abstract : We have studied the effect of heavy-ion irradiation on $(PEO)_{1-x}$-$(NH_4ClO_4)_x$ films containing 5% laponite as an additive and x varying in the range 16-22wt%. Impedance spectroscopy and differential scanning calorimetry (DSC) have been done before and after irradiation by 160 MeV Ne-ions. It has been found that irradiation reduces the ion-conductivity and increases the melting point of the polymer electrolyte. DSC results indicate that the reduction is due to cross-linking of polymer chains and increased crystallinity. The effect is more pronounced at the composition with 19 wt% NH_4ClO_4.

Keywords : Polymer electrolyte, ion-irradiation, impedance spectroscopy, differential scanning calorimetry.

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Influence of plasticizer on the conductivity of PMMA–based proton conducting gel electrolytes

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Abstract : The ion conducting properties of a gel electrolyte prepared by incorporating ammonium thiocyanate (NH_4SCN) in polymethyl methacrylate (PMMA) matrix in three solvent systems have been reported here. Dimethyl formamide (DMF) has been used as a solvent for preparation of liquid electrolyte and ethylene carbonate (EC) and propylene carbonate (PC) have been used as plasticizer. Addition of conventional plasticizing agents EC and PC to DMF has been found to enhance the ionic conductivity of liquid and gel electrolytes ($\sigma_{liq\ DMF} = 2.72X10^{-2}$ Scm^{-1}; $\sigma_{gel}=5.1\times 10^{-3}$ Scm^{-1}) significantly with highest conductivity values for electrolytes containing both EC and PC. Addition of PMMA to liquid electrolyte in the given range results in decrement of ionic conductivity with the fall lying within an order of magnitude. Temperature dependence of ionic conductivity depicts VTF behavior to indicate liquid like ion transport in the gel electrolytes.

Keywords : Polymer electrolyte, polymer gel electrolytes, ionic conductivity, plasticization

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AC impedance and dielectric spectroscopic studies of proton conducting PVAc- PVdF blended polymer electrolytes

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Abstract : The blended proton conducting polymer electrolytes comprising of poly(vinyl acetate) (PVAc) and poly(vinylidenefluoride) (PVdF) have been prepared for different ammonium thiocyanate (NH_4SCN) ratio by solution casting technique. The ac conductivity and dielectric spectroscopy studies have been carried out on the blended polymer matrix to reveal the H^+ conductivity. The high frequency semicircle in the impedance plot reveals the bulk effect of the polymer electrolytes. The proton conductivity has been found to vary from ~$1.7x10^{-7}$ Scm^{-1} to $4.6x10^{-4}Scm^{-1}$ with the increase in salt concentration in the blended polymer matrix at ambient temperature. The ionic transference number of mobile ions has been estimated by Wagner's polarization method and it has been found to be t_{ion}~0.97 for all the samples. The dielectric spectral studies show the low frequency dispersion, which implies the space charge effects arising from the electrodes.

Keywords : Impedance spectroscopy, blend polymer electrolytes, proton conductivity, transference number, dielectric analysis

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Investigation of swift heavy ion irradiation (160 MeV, Ni^{12+}) effects on polypyrrole conducting polymers used as electrode materials for all polymer redox supercapacitor

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Abstract : Electronically conducting polymers are suitable electrode materials for high performance supercapacitors for their high specific capacitance and high dc conductivity in the charged state. Supercapacitors and batteries are energy storage and conversion systems which satisfy the requirements of high specific power and energy in a complementary way. Ion beam (energy >1MeV) irradiation on the polymer is a novel technique to enhance or alter the properties like conductivity, density, chain length and solubility. Conducting polymer polypyrrole thin films doped with $LiClO_4$ are synthesized electrochemically on Indium Tin Oxide (ITO) coated glass. The polymer films are irradiated with 160MeV Ni^{12+} ions at different fluence 5×10^{10}, 5×10^{11} and 3×10^{12} ions cm^{-2}. dc conductivity measurement of the irradiated films show 50-60% increase in conductivity. Absorption increases in the higher wavelength region in the UV-VIS spectra, but no significant changes have been obtained in the FTIR spectra. The capacitance of the irradiated films is lowered. However, the capacitance of the supercapacitors with irradiated film shows enhanced stability compared to the devices with unirradiated films while characterized for cycle life up to 10,000 cycles.

Keywords : Polypyrrole, supercapacitor, ion irradiation, cyclic voltammetry, dc conductivity, UV-VIS, FTIR.

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Studies on proton conducting polymer electrolytes gelled with PVdF and PVdF-HFP

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Abstract : Non-aqueous proton conducting polymer gel electrolytes containing different weak carboxylic acids viz. ortho-, meta-, para- hydroxybenzoic acid (o-HBA, m-HBA, p-HBA) and succinic acid (SA) gelled with polyvinylidenefluoride (PVdF) and polyvinylidenefluoride-co-hexafluoropropylene (PVdF-HFP) have been synthesized and characterized in the present study. The conductivity of these electrolytes has been found to be of the order of 10^{-4} S/cm at room temperature and they show excellent stability over the operational temperature range. The conductivity of these electrolytes has been found to depend on dissociation constant of acid, nature of the solvent and the concentration of the polymer used. The addition of polymer to these electrolytes results in change in the electrical properties which has been explained to be due to the active role played by the polymer.

Keywords : Polymer gel electrolytes, weak acids, dissociation constant, ion aggregates, undissociated acid, ionic conductivity.

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Electrical conduction in wax and natural gum resin

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Abstract : The present study makes an attempt to investigate the nature of electrical conduction in wax, natural gum resin and some of their complexes. It has been found that pure paraffin wax and pure gum resin exhibit poor ionic conduction, however, their complexes developed by introducing Cu, Ni and Li compounds exhibit a conductivity enhancement by a factor 100 to 1000 times over its natural phases. This study also compares the electrical conductivity of natural Bee wax.

Keywords : Paraffin wax, bee wax, gum resin, inorganic compound, electrical conductivity

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Ionic conductivity studies of PVA –PVP blends

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Abstract : The PVA / PVP blended polymer electrolytes with ammonium thiocyanate as dopant have been prepared by solvent casting technique having different blend ratio. The blended polymer complexes have been characterized by AC impedance spectroscopy in the frequency range of 42 – 1M HZ over the temperature range of 303 – 373 K. The bulk conductivity values are found to depend on the blend ratio of the polymers for constant salt ratio. The blended polymer complexes exhibit the Arrhenius behaviour in the temperature range studied. The high conductivity at ambient temperature has been observed for 75PVA-25PVP blend ratio and is found to be 2.5×10^{-6} S Cm^{-1}. The activation energy for this system is found to be 0.49 eV, which is less than what is found in the other blended systems. The higher dielectric constant is observed for 75PVA-25PVP blend ratio and is due to the electrode polarization.

Keywords : Blending of polymer, polyvinyl alcohol, polyvinyl pyrrolidone, impedance spectroscopy, dielectric constant.

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Ionic conduction studies in C^{5+} ion irradiated P(VDF-HFP)-(PC+DEC)-$LiClO_4$ gel polymer electrolyte system

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Abstract : In the present work, P(VDF-HFP)-(PC+DEC)-$LiClO_4$ gel polymer electrolyte system, irradiated with C^{5+} ions at nine different fluences, is studied. The maximum room temperature conductivity is found to be of the order of 10^{-4} S/cm. Irradiation with swift heavy ion shows enhancement of conductivity at lower fluences and decrease in conductivity at higher fluences with respect to pristine polymer electrolyte films. This interesting result could be attributed to the fact that for a particular ion beam with a given energy, higher fluence provides critical activation energy for crystallization to occur, which results in decreased ionic conductivity. XRD results show decreased crystallinity below and increased crystallinity above the critical fluence after irradiation, which supports this view. FTIR spectra show the polymer-salt interaction before and after irradiation.

Keywords : Ion irradiation, fluence, gel polymer electrolyte, ionic conductivity, XRD, FTIR

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Formation of polyethylene oxide-based composite polymer electrolytes blended with Al_2O_3 nanoparticles

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Abstract : Design and fabrication of a new class of solid polymer electrolytes based on polyethylene oxide (PEO) and silver triflate ($AgCF_3SO_3$) together with nanometer-sized Al_2O_3 dispersoid material in the form of thin films are reported in this work. It has been found that an O/M (oxygen/metal) value of 50 within the acetonitrile-based polymer/salt complex viz., PEO-$AgCF_3SO_3$ would yield more stable thin films than in the case of O/M = 30. For accurate thickness measurements, one of the best-known optical techniques involving an air-wedge arrangement has been successfully employed during the course of the investigation. The complex impedance analysis of such films has been made over the frequency domain 1 MHz - 20 Hz and in the temperature range 295 - 330 K. The present electrical transport results have revealed that the measured room-temperature electrical conductivity (σ) of the typical nanocomposite polymer electrolyte $P(EO)_{50}$ $AgCF_3SO_3$-5wt% Al_2O_3 (n) is 1.33×10^{-5} Scm^{-1}. This is four orders of magnitude higher than that of the polymer host, PEO thus suggesting the feasibility of enhancement in the electrical conduction as a result of incorporation of Al_2O_3 nanoparticles.

Keywords : Polymer electrolytes, thin films, nanomaterials.

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