CHAPTER-1

INTRODUCTION
1.1. Historical perspective of Solid State Ionics:

Preparation of Solids, Characterization of Solids in different ways the field of materials science i.e. solid state ionic plays a vital role. The ionic conductivity phenomenon, transport properties were also explained by solid state ionics. The main approach of solid state ionic was studied the ionic conductivity in solids. It was seemed to be certain materials exhibit low conductivity due to mass transportation in solids. So the researchers focused on different materials to obtain better ionic conductivity in the early of 1960s. Fast ionic conductors and superionic conductors were developed for getting high ionic conductivity. These conductors exhibited better conductivity when compared to the liquid electrolyte. The reason only leakage problem occurred in liquid electrolytes. The solid-state electrolyte explores a number of advantages when compared to the liquid type of electrolytes. These types of electrolytes were also operated at ambient temperatures. The general requirements of solid-state electrolytes are

- Posses the maximum Ionic conductivity
- The electronic conductivity was negligible
- Perfect mechanical strength
- Simple fabrication
- Low cost

The present technologies like the development of batteries, electrochemical cells, electronic devices, smart phones etc depend upon of solid state ionics. From the last third century, this field comes very attractive to researchers [1-2]. Before one hundred and fifty years ago the ionic conductivity of solid state electrolytes can be observed. In 1834 Faraday explains the transport properties of Ag⁺. The first research article published on ionic conductivity of CuI [3-4]. Since last three decades, a lot of researchers focused on glassy materials, amorphous materials and lithium-ion materials. The conductivity of these materials determined at distinct ambient temperatures. Highest ionic conductivity of solid electrolytes represented in Fig.1.1.Since last five decades.
Fig. 1.1. The developed solid electrolytes at room temperatures.

(a). Silver iodide $10^{-4}$ S/cm, had the value of $10^{-6}$ S/cm; (b). Reuter and Hardell [5];
(c). Takahashi and Yamamoto [6]; (d). Bradley and Greene [7]; (e). Owens and Argue [8];
(f). Takahashi et al. [9].

1.2. An Introduction to Solid Electrolytes:

1.2.1. General Properties:

- Solid electrolytes exhibiting no of positive ions and negative ions.
- A large no of empty sites possessed by solid electrolytes.
- These sites should have potential energies and low activation energies.
- The structure of solids must exhibit solid framework.

1.2.2. Different types of Solid Electrolytes:

Owing to the variability of in materials, structures and Solid Electrolytes are broadly
classified into different categories such as crystalline, glassy, polymer, composite
electrolytes etc. Let us have a brief look at them.
1.2.3. Framework crystalline / polycrystalline solid electrolytes:

The framework crystalline/polycrystalline superionic solids, usually prepared by the solid solutions reaction, invariably contain two sub-lattices: a rigid cage-like skeleton within which a molten sub-lattice is enclosed facilitating liquid like the movement of ions. The superionic materials developed at an initial stage and explore the better properties of electrochemical cells. [Chandra el al1976, 1978, 1980, 1980a, 1980b; Kennedy 1977; Mahoney 1978; Agrawal 1980].

1.2.4. Glassy / amorphous solid electrolytes:

In the 1970s the researchers were attracted to amorphous and glassy state electrolytes due to their different properties when compared to another type of electrolytes. Ease of preparation into desired shapes with the possibility to form thin films etc. [Laskar & Chandra 1989]. Fast ion conduction in a melt-quenched glassy system: AgI- Ag₂SeO₄ can be reported in 1973 [Kunze et al 1973]. Ag⁺ electrolyte system having better ionic conductivity is order of 10⁻² S/cm. Since then, large numbers of superionic glasses exhibiting different mobile ions viz. Ag⁺, Cu⁺, F⁻ etc. have been reported [Minami 1987; Fusco and Tuller 1989; Angell 1983, 1986, 1990; Julien and Nazlini 1994; Souquet d to 1995; Takahashi 1995; Chowdari et al 1986, 1994,1996,1998, 2002,2004, 2006; Maier 2000; Owens 2000; Badwal 2002; Hull 2004; Sunandana and Kumar 2004; Ivers- 2006]. Different theories have been proposed for explaining the ion transport phenomenon in solid electrolyte systems. Some important theories are mentioned as below:

- Anderson-Stuart (A-S) model [Anderson & Stuart in 1954].
- Anemic Electrolyte model [Ravaine and Souquet 1977, 1978].
- The Bypass model [Ingram in 1988].
- Ion-Association model [Chandra & co-workers 1994, 1996].
1.2.5. Composite solid electrolytes:

Composite solid electrolytes, also referred to as ‘solid electrolytes’, are better conducting multiphase solid systems attracted great technological attentions after 1973 as potential candidates for all-solid-state electrochemical device fabrication. They are mostly two-phase mixture, containing a moderately conducting ionic solid such as AgI, CuI etc. as 1st phase host salt and a 2nd phase material, which may be either an inert insulating compound such as Al₂O₃, SiO₂, ZrO₂, Fe₂O₃ etc. or another low conducting ionic solid such as AgBr, AgCl, KCl etc. Both the phases coexist together separately in the composite system. Composite electrolyte systems have been grouped into following two broad categories:

• **Inorganic Composite Electrolytes:** They are either crystal-crystal composite electrolytes viz. moderately ion conducting alkali/silver halide salts dispersed with insulating/inert materials such as Al₂O₃, SiO₂, ZrO₂, fly-ash etc. or crystal-glass composite electrolytes viz. ion conducting glass dispersed with above mentioned insulating/inert materials.

• **Organic Composite Polymer Electrolytes:** They are either crystal-polymer electrolyte composites viz. (SPEs).

1.2.6. Polymer electrolytes:

The complexation of doped ionic salt with PEO (Polyethylene oxide) reported by Fenton in 1973. The various researchers focused on polymer electrolytes due to their versatile properties and maintaining good mechanical properties which lead to interfacial contacts with electrode materials. The properties of polymer electrolytes given as follows.

➢ Polymer electrolytes posses the strong coordinating capability with cations.
➢ The atoms of polymer chains must have no shared electrons.
➢ They must possess better mechanical properties
➢ The polymer electrolytes form in different shapes due to good mechanical strength.
➢ These polymer electrolytes exhibit high melting point
These were operated at high temperatures.
To attain the high amount of ionic conductivity liquid electrolytes can be absorbed.

1.3. A broad classification of polymer electrolytes:

To prepare polymer electrolytes different methods are being used by the researchers. These materials were systematically designed and developed. The different preparation methods illustrated as follows
- Polymer –Salt complexes
- Polymer Gel electrolytes
- Composite polymer electrolytes
- Plasticized Nanocomposite polymer composites

1.3.1. Polymer-salt complexes

SPEs were synthesized by mixing of salts into polymer matrix. The host polymers having high molecular weight (Mw). After the ionic salts doped host polymer matrix the crystalline nature can be decreased due to complete dissolvation of salts in host polymer matrix. The doped ionic salts provide free volume model to transfer ions in the electrolyte system. In this process, ionic salts act as a plasticizer. So that they behave more flexible. Due to a huge degree of amorphous nature, the crystalline nature can be reduced. Finally, the salt complexed polymer electrolytes explores the structural and complexation properties when compared to salt-free polymers

1.3.2. Polymeric Gel Electrolytes:

The GPEs advantageous over both solid electrolytes and liquid electrolytes. Due to leakage problem, evaporation problem in the liquid type of electrolytes and low ionic conductivity in behalf of solid electrolytes the gel type of polymeric electrolyte films were prepared. These types of GPEs overcome drawbacks which were possessed by solid and liquid electrolytes. The safety performance was also improved when compared to solid and liquid electrolytes. The efficiency of fabrication improves by eliminations of evaporation problem. Polymer gel an electrolyte belongs to the latter case were also called "plasticized polymer electrolytes". The essential properties required for the salt and solvent to prepare stable and exhibit a maximum number of negative ions and less dissociation energy. Due to these one gel polymer electrolytes
explores high dielectric constant and the high boiling point which leads to high ionic conductivity [10].

1.3.3. Composite polymer electrolytes:

The composite polymer electrolyte systems were also called as blended polymer electrolytes. In addition to nanofillers to the host polymer electrolytes, these type of polymer electrolytes can be fabricated [11-12]. The composite polymeric electrolytes conductivity depends upon doped nanofillers and doped polymers. To amplify the physical conditions of composite polymeric electrolytes the filler size plays a vital role [13-16].

1.3.4. Plasticized-nano composite polymer electrolytes:

Plasticized nanocomposites polymer electrolytes synthesized by doping of the nanosized ceramic fillers to the polymeric substance. Mechanical properties and ionic conductivity properties strengthened with doping of the nanosized fillers to plasticized polymeric electrolyte systems. In addition to nanofillers to the plasticized polymer electrolytes, the crystalline nature can be reduced. Due to this reason, the amorphous nature increased which leads to exhibit high conductivity properties. In the present research work the ceramic fillers ZrO$_2$ and Al$_2$O$_3$ used for gaining the high ionic conductivity.

1.4. Characteristics of salts to favor complex formation:

To strengthen the conductivity properties of processed GPEs salts were doped with the pure polymer host. A number of advantages achieved like mechanical strength improvement, different shapes of electrolytes and flexibility due to doping of ionic salts to the host polymers. A proper balance was also maintained in between mechanical strength and ionic conductivity. The fabricated salt complexed polymer electrolytes exhibit different applications in electronic devices like capacitors and electrochemical cells [17]. In general, the doped salts having a low amount of lattice energy. Polymers easily interact with doped salts due to their low cohesive energies. For polymer systems, the enthalpy changes due to solvation of salt with host polymers. The thermodynamical
properties like endothermic and exothermic properties, changing of melting temperatures of the polymer electrolytes was varied in addition of salts to the host polymer matrix.[18-26]

1.5. Applications of Polymer Electrolyte Materials:

As already mentioned earlier, Solid State Ionic materials, in general, and polymer electrolytes, in particular, show tremendous technological scopes in developing electrochemical cells, memory devices etc. A brief review of various utilizations aspects of polymeric materials has been made in this section. It has been also pointed out that polymer electrolytes show many of beneficial materials and characteristics of solid electrolyte systems. Polymer electrolytes are in the thin film mini/micro flexible membranes with high mechanical integrity, which favor them for the thin devices of desirable shapes and sizes. The ionic conducting polymer electrolytes used in various fields such as [27-28].

➢ Li-Ion batteries
➢ High power super capacitors
➢ Gas sensors
➢ Electro chromic displays
➢ Electrochemical cells
➢ High-density batteries
➢ Fast ionic conductors
➢ Energy storage devices
➢ Electric motor vehicles
➢ Personal computers

1.6. Introduction to Battery and its components.
In general, the batteries were fabricated within series mode or parallel mode of cells. These type of cells used to convert the chemical to electrical energy. Different types of electrochemical changes occurred at cell's electrodes. If the cells were reversible then the cell may be recharged. Generally, a cell composed of three different components such as
• **Anode:** It was the anode electrode of given cell. The anode associated with oxidation means that electrons were released into the external circuit. In the cell, the positive electrode acts as negative pole during discharge and as cathode pole during charge.

• **Cathode:** It was the cathode electrode of given cell. The anode associated with electrons was taken from the external circuit. In the rechargeable cell, the cathode acts as cathode pole during discharge and as anode pole during charge.

• **Electrolyte.** The electrolyte was a material which contributes the conductivity in between the positive and negative electrodes. This electrolyte permits the mobility of anions and cations towards into opposite sides while operating of the cell. The electrolyte having the formation of organic or inorganic solutions. [29].

• Exhibit maximum potential
• During battery discharge potential varied slightly.
• Less weight
• operated at wide range temperatures.
• Electrolyte synthesis very easy.
• Less cost
• Less toxicity

1.6.1. **Basic Battery concepts &types:**

Batteries provide well-contained energy conversion devices which greatly contributed to the needs of mankind. Zero emission vehicles of the future will be battery powered only. Many non-polluting energy conversion devices such as photovoltaic systems require the concomitant use of rechargeable batteries for energy storage. The size of the battery ranges from a tiny coin to that of a large house. Tiny coin and button-sized cells are used for electronic applications requiring only small capacity. Liter-container sized batteries are commonly used in motor vehicles for starting, lighting and ignition purposes. The basis for Battery technology is that the chemical energy derived from the chemical reactions in the battery is changed into electrical energy. This is in contrast to what happens in heat engines, where intermediate thermal or combustion processes. Therefore due to the direct reformation of chemical to electrical energy in a battery, all
the free energy of the chemical system is available for conversion. In heat engines, such conversion efficiency is limited by the Carnot cycle. Further, the conversion of electrical to mechanical energy is quite efficient because of the inherent simplicity and low friction of electrical motors. This is the basis for many applications of batteries. Conversion of electricity to light or sound is also efficient and easily controlled, thereby enabling development several applications of Batteries for lighting or creation and reproduction of sound. As is the case with any energy conversion device, in batteries there are losses, and there have been constant efforts to minimize the same.

Batteries are broadly classified into the following three categories:

- **Primary battery**: Which is designed to be discharged only once and discarded.

  ![A Schematic Diagram of Primary cell](image.png)

  **Fig.1.2**. A Schematic Diagram of Primary cell

- **Secondary Battery**: Which is rechargeable and can be used as the primary battery, then recharged and used again, the cycle is repeated until the capacity fades or is lost suddenly due to an internal short circuit.
• **Reserve Battery**: in which active materials are kept separated by a special arrangement. When it has to be actually used, an activation device makes it ready. Such a battery is designed for long storage before use.

![Fig.1.3.A Schematic Diagram of Secondary cell](image1)

**Fig.1.3.A Schematic Diagram of Secondary cell**

**Fig.1.4.A Schematic Diagram of Reserve Battery**

### 1.6.2. Working Principle of Battery:

In solid polymer battery, the polymer electrolyte is used as an intermediate medium between two electrodes, one of the electrodes is act as positive and another is the negative electrode. However positive electrode contains the plastic, elastic and flexible materials while at negative electrode the material foil is used [30-31]. The mechanism lies in a battery in which the metal ions are accumulated in the cathode material as a
layer. The moment of ions in those layers are called as intercalation. During this process, the metal ions inside the cathode material swell apart such that it flexible with the contact of electrodes even the change of size and shape. The cathode material of polymer electrolytes in the solid state battery is employed as a plastic matrix. Some carbons are added to the electronic conductor in order to form the cathode material to get the current collector, such that the electrons can be penetrated or discharge through it. When the alkaline salt dissolved in the host polymer with the suitable solvent after complete mixing of doped salt in the polymeric substance, on further evaporation mechanically it gets completely solid form but in internal behavior, it resembles and looks like the liquid state. In a Solid state electrolyte, the conduction process takes place due to ions rather than electrons [32-36].

Fig. 1.5: Schematic representation of polymer electrolytes based solid state battery.

Most of the polymeric materials are insulators which neither conduct electricity in the medium through ions or electrons. Some of the polymers are “immobile solvents” at which the salt and the polymer are completely mixed and act as a polymer electrolyte.

1.7. Properties for Choosing Electrolyte System:
An electrolyte is a chemical compound system which conducts the electricity by changing of ions from one electrode to other electrodes. An electrolyte plays a vital role in fabricated solid state electrochemical cells. The ionic conductivity may be high at ambient temperatures. Electrolytes having high ionic conductivity and less amount of electrical conductivity to avert discharge of the cell. The electrolytes mostly exhibiting transport ionic numbers were 0 to 1. These type of electrolytes were stable under different temperatures and pressure.

1.8. Electrical and mechanical effects in the construction of a battery:

At the electrodes in a battery, the Energy loss should be increasing the ionic and electronic conductivity. While packing of a battery the inside material should contain the electrical, mechanical parameters. During the usage of the battery, external valves should be maintained. On demanding of universal applications the size of the batteries should be minimized as button or coin cell type batteries [37-38].

1.9. Study of polymer battery parameters:

To study the prepared GPE films, solid state battery was made with suitable positive and negative electrodes. Linford [39] had been reported studies of solid state battery. The open circuit voltage was first battery parameter measured from that fabricated electrochemical cell. The open circuit voltage measured under applied certain load resistance. At the time of designing a battery, the following points can be considered.

➢ Electrolytes must possess with high ionic conduction
➢ Electrolyte inter spacial resistance can be reduced
➢ To get uniform current density the cells can be optimized

The other following basic cell parameters were also have been evaluated.

➢ Electric power : \( P=VI=I^2R=V^2/R \) [W]
➢ Electric Energy : \( E= VI.t = Qv \) [Wh]
➢ Current density : \( J=I/A \) [Amp/cm²]
➢ Discharge capacity : current x Discharge time [Ah]
1.1. Recent Progress of the Polymers:

For the last few decades, the field of conducting polymer electrolytes has been expanding rapidly due to anomalous properties of different polymer materials. This properties very attractive feature for fabricating the energy storage technologies the conducting polymers plays a major role. Over the last few years, many researchers focused on solid-state electrolytes which can be fabricated from conducting polymers due to the rapid development of technological advantages. These polymer electrolytes are found to have wide range applications in high advanced battery applications and smart windows. Conducting polymers also used in medical technology, transport technology, agricultural technology etc. The polymers used in mainly sensors technology which helps for identifying the environmental changes, pollutants in water and gases. Nowadays polymers used as electrolyte systems in electrochemical cells for gaining high ionic conductivity. Dry polymer electrolyte batteries were used in space stations for their operation.

1.11. The modernity of the work:

Among the polymer electrolytes have been studied, GPEs were find out very auspicious when compared to solid and liquid electrolyte properties. In general, the gel polymer electrolytes were obtained from swelling the polymer in the solvents consisting of metal ions. In-gel polymer electrolytes doped salt provides ions for conduction and solvents helps for dissolution. These doped salts and ceramic fillers improve the mechanical stability [40]. Fenullade and Perche [41] explore plasticizing polymers with an aprotic solution containing an alkali metal salt in 1975. the formation of gels with a very high ionic conduction like polymer gel electrolytes with a number of polymer hosts, namely, poly(ethylene oxide) (PEO) [42], poly(vinylidene fluoride) (PVdF) [43-44], poly(acrylonitrile) (PAN) [45–51]. In the current research, Gel polymer electrolytes were synthesized by adding ionic salts like ammonium Trifluoromethane sulfonate and sodium salt (NaF) to the host polymer PAN. To improve ionic conductivity the ceramic nanofillers were dispersed into salt complexed polymer electrolytes.
The present thesis work reports that GPEs films based on Polyacrylonitrile (PAN) complexed with doped salts Ammonium Trifluoro methanesulfonate (NH₄CF₃SO₄), Sodium Fluoride (NaF), with ZrO₂ & Al₂O₃ nanofiller respectively. The objectives of the current thesis entitled “Development and Characterization of Nano Filler Doped – PAN Based Gel Polymer Electrolytes for Electrochemical cell Applications” are given below.

- The GPEs for Pure PAN and (PAN+NaF) (PAN+ NH₄CF₃SO₄), (70PAN+ 30NaF + wt%ZrO₂) and (70PAN+ 30NaF+ wt%Al₂O₃) were prepared by solution casting technique.
- XRD, FTIR Spectroscopy, DSC technique, SEM and Ultra-Violet Spectroscopy studies revealed the crystalline nature and chemical complexation of doped polymer with salts and nano fillers.
- Conductivity studies for the prepared GPEs within temperature limits 303-373 K, measured with the help of HIOKI 3532-50 LCR Hi Tester & with wt% of salts, nanofillers and several temperatures dependence of conductivity also studied.
- Wagner’s polarization technique can be used measured for ionic and electronic transport numbers of all prepared samples by using Keithley 6514 electrometer.
- To fabricate Solid state battery in the configuration negative electrode/polymer electrolyte/positive electrode using PAN+NaF, PAN+ NH₄CF₃SO₄), (70PAN+ 30NaF +4wt%ZrO₂) and (70PAN+30 NaF+3wt%Al₂O₃) electrolytes and to evaluate OCV, SCC, Current per unit area, Power per unit area, Energy per unit area, Discharging time.

Finally, solid-state batteries were constructed with the help of optimized GPE/NCPE films and study of device performances under different load conditions.

1.13. ORGANIZATION OF THE THESIS – This current thesis has been discussed in five chapters.

CHAPTER 1: INTRODUCTION
Chapter 1 of the thesis mainly explores introduction, various types of polymer electrolytes and special features of salt complexed polymers. The technical application aspects of the Polymer Electrolytes in various fields are elaborated. The introduction, design and working principle of polymer batteries are also mentioned. The criteria for choosing electrolyte materials along with performance parameters of polymer batteries are also discussed. Various advantages of solid-state polymer batteries are enlightened.

CHAPTER 2: MATERIALS AND EXPERIMENTAL TECHNIQUES

Chapter 2 explores the materials which were involved in this research work and their properties and different experimental techniques for PAN-based gel polymer electrolytes. Characterization technique like XRD, FTIR, SEM. The UV-Visible spectroscopy, Differential Scanning Calorimetry Techniques (DSC), Ion Conductivity studies, AC impedance spectroscopy and DC polarization techniques, Wagner’s polarization studies for charge transport. Fabrication details of solid state electrochemical cells based on these polymer electrolyte systems are given along with the cell discharge studies.

CHAPTER 3: STRUCTURAL AND COMPLEXATION STUDIES OF PAN BASED GEL POLYMER ELECTROLYTE FILMS WITH INFLUENCE OF SALTS AND NANOFILLERS.

Chapter 3 mainly deals with the result of X-Ray diffraction, IR spectroscopy, DSC, SEM, UV-Vis spectroscopy of PAN complexed GPEs with NH₄CF₃SO₄, NaF salts using plasticizers such as Ethylene Carbonate and DMF and nano-fillers such as ZrO₂ and Al₂O₃. The results on XRD study of polymer complexed films showed with amplify in the concentration of the salt in the polymeric substance, the degree of crystallinity of the polymeric substance reduced due to an indicating the total dissolvation of the salt and dispersed nanofillers with the polymer. The appearance of new peaks and new-bands along with the changes in the existing peaks (and/or disappearance) revealed by FTIR Spectroscopy. From the results indicated the complexation of salt with the polymeric substance. For the polymer-salt complexation the DSC, UV-Vis and SEM techniques can be used. From these studies, new changes
can be observed with the existing polymers. Finally, this chapter mainly explores characterization of pure polymer electrolytes and addition of salts and dispersed nano fillers which confirms the complexation studies.

**CHAPTER 4: ELECTRICAL CONDUCTIVITY AND TRANSPORT PHENOMENA OF PAN BASED GEL POLYMER ELECTROLYTE MEMBRANES WITH INFLUENCE OF SALTS AND NANOFILLERS.**

Chapter 4 mainly explores on Electrical conductivity and Ion transport theory related to conducting polymer system of PAN complexed GPEs with NH$_4$CF$_3$SO$_4$, NaF salts using plasticizers such as Ethylene Carbonate and DMF and nano-fillers such as ZrO$_2$ and Al$_2$O$_3$. This chapter mainly deals with the transport phenomena to understand the charge transport in GPEs films. Technique of Wagner’s polarization can be used measured for ionic and electronic transport numbers of all prepared samples by using Keithley 6514 electrometer. The composition dependent conductivity plots explained.

In addition of plasticizers like DMF, EC, salts NH$_4$CF$_3$SO$_4$, NaF, and nano-fillers such as ZrO$_2$ and Al$_2$O$_3$ to the polymer electrolyte system showed an enhanced conductivity compared to the pure polymer electrolyte system and the results obtained are given in this chapter. To get the point of charge transport in these polymeric electrolytes, the results of D.C Conductivity measurements at room temperature (303-373K) are given. The conductivity temperature plots showed two regions near by the melting point (T$_m$) of the polymer. To understand the ion transport of in these polymer electrolytes, the results of A.C Conductivity measurements are given. The bulk resistances (R$_b$) of all the prepared samples were measured from the complex impedance data collected from the temperature range 298-363K using computer controlled Hewlett-Packard model Hp 4284 with frequency range 1MHz-20Hz. The data were obtained for Pure PAN (polyacrylonitrile) and four individual compositions of the salts NH$_4$CF$_3$SO$_4$, NaF, and nano-fillers such as ZrO$_2$ and Al$_2$O$_3$ respectively by employing a specially designed conductivity cell having a fixed sample thickness of 2 mm. The samples are effectively held between a pair of cylindrical silver non-blocking electrodes. The electrical equations

\[
\sigma = \frac{1}{R_b \left( \frac{t}{A} \right)} \quad (1.1)
\]
Where A is the area of cross-section, t is the thickness of the samples, \( R_b \) is the bulk resistance

According to an Arrhenius

\[
\sigma = \sigma_0 \exp\left(-\frac{E_a}{kT}\right)
\]  

(1.2)

CHAPTER 5: FABRICATION OF ELECTROCHEMICAL CELL AND ITS DISCHARGE CHARACTERISTICS.

Chapter 5 explores that fabrication and discharge characteristic studies of electrochemical cells which are exhibiting long storage life, rugged structure, and operation over a wide temperature range etc. These prepared electrochemical cells offer several benefits against the liquid and solid systems such as low amount of leakage and their wide working temperature range. The electrochemical cells prepared based on conducting gel polymer electrolytes (70PAN:30NH\(_4\)CF\(_3\)SO\(_4\)), (70PAN:30NaF), (70PAN:30NaF:4wt\%ZrO\(_2\)), (70PAN:30NaF:3wt\%Al\(_2\)O\(_3\)). The cell with configuration negative electrode/polymer electrolyte/positive electrode (I\(_2\) (Iodine) +C (graphite) +Electrolyte) showed better performance characteristics compared to various configurations used in the present electrochemical cell studies. The discharging curves of various electrochemical cells are studied with a constant load and some kind of cell parameters such as OCV, SCC, power density, energy density etc are evaluated. The present cells data were in comparison of previous noted electrochemical cells data. Ammonium triflate, sodium fluoride with ZrO\(_2\) and Al\(_2\)O\(_3\) based polymeric gel electrolytes are found to offer an interesting alternative to earlier electrochemical cell polymeric electrolyte systems

- Conclusions.
- Summary.
- Scope for future work.

References


