CHAPTER 8

SUMMARY AND CONCLUSION

In the present investigation, different composition of polymer electrolytes have been prepared using solution casting technique and the systems are mentioned below: (x in mol%)

1. xPVA:(100-x)PVdF:1LiCF$_3$SO$_3$ (x=90, 80 and 70)
2. 80PVA:20PVdF: xLiCF$_3$SO$_3$ (x=5, 10, 15 and 20)
3. (100-x)(80PVA:20PVdF:15LiCF$_3$SO$_3$): xEC (x=10, 20, 30 and 40)
4. 80PVA:20PVdF:15LiCF$_3$SO$_3$:xSiO$_2$ (x=2, 4, 6, 8 and 10)
5. 80PVA:20PVdF: 15LiCF$_3$SO$_3$:xTiO$_2$ (x=2, 4, 6 and 8)

Different techniques such as blending (PVA:PVdF), plasticization (EC) and incorporation of nanofiller (SiO$_2$ and TiO$_2$) have been implemented to enhance the properties of solid polymer electrolyte.

- XRD pattern reveals that the interaction of LiCF$_3$SO$_3$, EC, nano SiO$_2$ and nano TiO$_2$ with the host polymer by the inference of change in peak intensity and high broadness of peak.
- Complex formation between host polymer and salt/plasticizer and also dispersion of nanofillers has been confirmed using FTIR for all the samples.
- DSC analysis confirmed that the optimized polymer electrolyte from each series possess highest ionic conductivity which is evident from its lower T$_m$. It is also well in accordance with XRD pattern.
Table 8.1 Ionic conductivity, melting temperature, thermal stability, tensile strength and electrochemical stability of the optimized polymer electrolytes in each series

<table>
<thead>
<tr>
<th>Sample code</th>
<th>Ionic conductivity at 303 K (Scm⁻¹)</th>
<th>Melting temperature (°C)</th>
<th>Thermal stability (°C)</th>
<th>Tensile strength (MPa)</th>
<th>Electrochemical stability (V) vs Li/Li⁺</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPE-I</td>
<td>2.7x10⁻³</td>
<td>158</td>
<td>130</td>
<td>10.5</td>
<td>5 V</td>
</tr>
<tr>
<td>GPE-I</td>
<td>7.6x10⁻⁴</td>
<td>166.6</td>
<td>144</td>
<td>8.6</td>
<td>5.6 V</td>
</tr>
<tr>
<td>NCPE-I</td>
<td>1.7 x 10⁻⁴</td>
<td>162.5</td>
<td>135</td>
<td>11.2</td>
<td>5.6 V</td>
</tr>
<tr>
<td>NCPE-II</td>
<td>3.7 x 10⁻³</td>
<td>165.8</td>
<td>145</td>
<td>22.6</td>
<td>5.7 V</td>
</tr>
</tbody>
</table>

- Table 8.1 shows ionic conductivity, melting temperature, thermal stability, tensile strength and electrochemical stability of the optimized sample from each series. It confirms that, NCPE-II is the best hybrid polymer electrolyte and it will be well suited for lithium ion battery applications.
- Doping of 15 mol% LiCF₃SO₃ in 80mol%PVA:20mol%PVdF exhibited the highest ionic conductivity at 303 K (BPE-I). However incorporation of EC and nano SiO₂ decreases the ionic conductivity of BPE-I. Hence with the expectation of still achieving highest conductivity, an attempt has been made to incorporate nanoTiO₂ in BPE-I. The same has also been achieved (ionic conductivity of 3.7 x 10⁻³ Scm⁻¹ at 303 K which is high compared to all the optimized samples in four series -BPE-I, GPE-I and NCPE-I,NPCE-II).
- DC polarization measurement confirms that the conductivity of the prepared polymer electrolyte is mainly due to the ions.
- LSV shows that electrochemical stability for all the optimized polymer electrolytes (BPE-I, GPE-I, NCPE-I, NCPE-II) is greater than 5 V vs Li/Li⁺ with low current density.
The suitability of the optimized polymer electrolytes for lithium ion battery has been checked. Cells have been constructed using BPE-I and NCPE-II with the cell configuration of LiCoO$_2$/80PVA:20PVdF:15LiCF$_3$SO$_3$/Li (cell-1) and LiCoO$_2$/80PVA:20PVdF:15LiCF$_3$SO$_3$:4TiO$_2$/Li (cell-2) respectively. Oxidation and reduction peaks have been obtained for the two cells with low current density.

- Open circuit voltage of the constructed cell-1 and cell-2 has been found to be 3.0V and 3.01 V respectively.
- Oxidation and reduction peaks have been obtained for the two cells with low current density as evident from CV curve which confirms the good compatibility of prepared polymer electrolyte with cathode material.

**Future Work**

In future, it has been planned to enhance the performance of lithium battery by enhancing the properties of polymer electrolyte with the irradiation techniques such as gamma ray and ultrasonic irradiation etc.