Chapter 6

Summary and Conclusions

Terpolymers are widely employed for various applications such as environmental remediation, pharmaceuticals and industrial applications due to their high flexibility in fine tuning their properties via facile modification of their chemical structure, composition and morphological features etc. The thesis focuses on the synthesis, characterization and various applications of terpolymers such as removal of toxic metal ions and dyes, membranes for the fuel cell and in-vitro biological applications.

Removal of toxic metal ions and degradation of dyes by terpolymer

Sorption processes are eco-friendly ways to remove the toxic metal ions and dye from wastewater. This process has proved its superiority to other conventional methods of wastewater treatments. These effective processes differ from the other treatment processes and also one of the best techniques for the treatment of various types of heavy metal ions and dyes. Accordingly, this system can be considered as a promising and effective alternative for the destruction of toxic metal ions and dyes present in waste water.

The sorption of heavy metal ions using a novel terpolymers such as SASF, DRF and DHF has been studied as a function of various parameters including concentration of electrolytes, pH, times of adsorption, dosage and desorption/reusability by batch adsorption technique. The experimental results indicated that surfactant mediated synthesis terpolymer has the highest adsorption capacity for the divalent toxic metal ions. The photocatalyti cactivity of the DRF terpolymer was evaluated by photocatalytic reduction of methylene blue (MB) dye solution. This degradation process was performed under solar photo-irradiation. As a result, the DRF terpolymer highly affects the optical property of light absorption and exhibits UV-visible light photoactivity which exhibits remarkably higher MB photodegradation rate, as expected and the photoselectivity of the novel DRF terpolymer towards photodecomposition rate of MB increases continuously with increasing irradiation time.

In vitro biological applications of terpolymer

The investigation of antibacterial and cytotoxicity activity of SASF terpolymer showed that the SASF terpolymer possessed effective antibacterial properties against both gram-positive *Methicillin-resistant Staphylococcus aureus (MRSA), Bacillus subtilis* and

gram-negative *Salmonella typhi, Escherichia coli* bacterial strains and the results obtained in this study demonstrate that the diameter of inhibition zone increases with increasing concentration of the terpolymer. Obviously, high concentration the terpolymer exhibits good antibacterial activity against the selected bacterial strains. The cytotoxicity studies reveal that the SASF terpolymer shows strong cytotoxic activity against Hela (mammalian cancer) cell line.

Mechanical properties of terpolymer composites

In the present investigation, composites film were made from TAF terpolymer and PVA. The mechanical properties of different ratio of TAF/PVA composites membrane and pristine PVA were investigated. On incorporation of TAF into PVA, the interaction due to hydrogen-bonding and electrostatic forces enhanced and thereby mechanical stability has been markedly improved.

The developed PVA-TAF terpolymer composite membranes show good thermal stability, flexibility, water uptake, and retention capacity. The prepared terpolymer composite membranes were thermally stable in a dry nitrogen atmosphere. Among the developed membranes, the one with the largest TAF content, i.e., PVA-TAF4 terpolymer composite membrane, exhibits an elongation at break of 26.4 %. When TAF content is at optimal level into PVA polymer matrix, higher IEC value (0.74 mequiv g^{-1}), water uptake (21.29 %) and proton conductivity (4.85×10^{-2} S cm-^{1}) were observed.

In conclusion, the present work can be considered as demonstrative in highlighting the potential of the novel PVA-TAF terpolymer composite membrane system that holds great promises in innumerable applications in both industry and technology

Future Work

The research work reported in this thesis on the synthesis of novel terpolymer and their various application in various fields have opened up many new perspectives for future research. They are as follows.

- The development of new terpolymer materials, especially those which are based on renewable resources, using innovative sustainable processes is of increasing interest and deserves the major attention of both academic and industrial research.
- Design and fabrication of new cross-linking terpoloymers can be used for zzbone implant applications