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It is certified that the work contained in the thesis titled “**Thermoplastic Polyurethane Ionomers as Gel Electrolyte for CdS Quantum Dots Sensitized Solar Cell**” by **Sunil Kumar** has been carried under my supervision and this work has not been submitted elsewhere for a degree.

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LIST OF ABBREVIATIONS

UV	Ultraviolet
FTIR	Fourier transforms infrared spectroscopy
SEM	Scanning Electron Microscopy
TEM	Transmission Electron Microscopy
DLS	Dynamic Light Scattering
CV	Cyclic Voltammetry
J_{sc}	Short circuit current density
V_{oc}	Open Circuit Voltage
FF	Fill Factor
PCE	Photovoltaic conversion efficiency
η	Efficiency
CE	Counter electrode
PTMG	Polytetramethyleneglycol
HMD	Hexamethylene diisocyanate
CE	Counter electrode
P_{MAX}	Maximum power density
HOMO	Highest occupied molecular orbital
LUMO	Lowest unoccupied molecular orbital
QDs	Quantum dots
QDSSCs	Quantum dots sensitized solar cells
E_g	Energy gap
R_{edox}	Redox potential
σ	Ionic conductivity
HSC	Hard segment content
PU	Polyurethane
PUI	Polyurethane ionomer
PE	Polyelectrolyte
SPU	Sulfonated polyurethane
SPUIG	Sulfonated polyurethane ionomer gel
LE	Liquid electrolyte
GPE	Gel polymer electrolyte

R_{CT}	Charge transfer resistance
GO	Graphene Oxide
SGO	Sulfonated grapheme Oxide
ESI	Electrochemical impedance spectroscopy
LSV	Linear seep Voltammetry
TGA	Thermogravimetric analysis
DTA	Differential temperature analysis
DSC	Differential scanning Calorimetry
T_{Gel}	Gel transition temperature
T_g	Glass transition temperature
T_m	Melting Temperature
PS	Photosensitizer
ETL	Electron transport layer
HTL	Hole transport layer
CEM	Counter electrode material

PREFACE

Quantum dot sensitized solar cells (QDSSCs) are highly interesting because of multiexciton generation (MEG) nature that can be used in achieving stable and higher efficiency solar cells. QDSSCs, having the advantages of low-cost assembling process, economically viable materials, and intrinsic optoelectronic properties of QD sensitizers, are regarded as attractive candidates for the low-cost third generation solar cells. The collaborative performance of QDSSCs is dependent on the charge excitation from the QD sensitizer, injection into the metal oxide (TiO_2), and transport in the circuit, as well as the transfer of the photogenerated holes and regeneration of the redox active electrolyte. The work intensifies the development of highly-efficient electrolyte matrix in the general field of QDSSCs. Redox active polymer electrolyte plays an important role to drive reversible and bidirectional charge transport within electronic device i.e., battery and photovoltaic device (solar cell). Redox active liquid electrolyte destroys the device structure due to corrosion, leakage and high penetration. Liquid electrolyte creates poor device performance and durability. Gel polymer electrolyte draws more attention towards electrolytic function because of better adhesion and interfacial contact. Research scientists have developed more number of redox active ionic couples (inorganic / organic couples and complex ions) for Quantum dot sensitized solar cell. Photovoltaic conversion efficiencies were found to be degraded due to poor performance of electrolyte. Recently, Science and technologies have ignited to develop highly efficient gel polymer electrolyte through functionalization, grafting or structural variation. Redox potential and electrical conductivity play a key role to estimate photovoltage of the device. Device efficiency can be improved by tuning the redox potential of electrolyte. Therefore, researchers are trying to develop composite gel polymer electrolyte to enhance the stability and durability of device. Gel polymer electrolytes provide an attractive choice for maintaining good ionic conductivity and reducing the cell leakage problems.

Hence the main objective of thesis is to develop efficient gel polymer electrolyte by using thermoplastic polyurethane ionomer. Thermoplastic pristine polyurethanes does not have sufficient electrical conductivity. However, electrical conductivity can be created through chemical and structural modification around hard segment content in polyurethane chain. By using chemistry, polyurethanes were converted into conductive matrix due to functionalization or grafting of redox active pendant group on urethane linkage. Short chain ionic group structurally modifies the physical properties of native polyurethanes. The ionic pendant group is preferred due to hydrophilic and stabilization efficiency in polyurethane chain. By changing the chemical environment around urethane linkage, redox properties have been tuned. The differential electrolytic (hole conduction) behaviour was observed with better interconnection in composite ionomer structure. Polyurethane ionomers having more oxygenic rich functional groups, showed efficient hole conduction because of greater interaction with nanopores of photoanode. Finally, GO implanted polyurethane ionomers have been developed for Quantum dots sensitized solar cell. The photovoltaic parameters were observed to be improved due to enhanced electrical conductivity and passivation effect of resultant gel polyelectrolyte. The complete synthesis, characterization and photovoltaic studies of the materials in QDSS cell have been discussed in the thesis. In summary, it can be concluded that polar functional groups are observed more efficient in electrolyte structure. The resultant gel polyelectrolyte functions as better substitute of traditional polysulfide electrolyte due to combined effect of redox mediation as well as interfacial passivation effect on photoanode.