

List of Figures

1.1	Typical solar radiation spectrum reaching on the earth's surface	3
1.2	Basic mechanism of photovoltaic cell	5
1.3	(a) I-V curve of solar cell under illumination and dark condition (b) Equivalent circuit diagram of a basic solar cell	9
1.4	NREL report representing different generations of solar cells along with their efficiencies	11
1.5	Schematic diagram representing (a) the basic components involved in DSSC (b) working of DSSC	17
1.6	Different geometries for incorporating metallic nanoparticles within the solar cell design	25
1.7	Collective motion of electrons in metal nanoparticle under external electric field	25
2.1	Photograph of (a) blank FTO (b) mesoporous TiO ₂ films doctor bladed onto patterned FTO (c) magnified view of (b), (d) dye loaded mesoporous TiO ₂ film (photoanode) (e) Pt coated counter electrode (photocathode) and (f) assembled DSSC using photoan- ode, photocathode and electrolyte	37
2.2	Schematic diagram of UV-Vis spectrophotometer	39
2.3	Photograph of UV-Vis spectrophotometer (Shimadzu, UV-VIS- NIR 3600 spectrophotometer)	41
2.4	Schematic diagram of FTIR	45
2.5	Photograph of FTIR (C92035 Perkin Elmer spectrometer)	47
2.6	Schematic diagram of XPS	49
2.7	Photograph of XPS (Mac-2 electron analyser)	51
2.8	Basic principle involved in the working of XPS	53
2.9	Schematic diagram of electron column part of SEM	55
2.10	Photograph of SEM (Carl Zeiss Supra 55)	57

LIST OF FIGURES

2.11	Schematic diagram of TEM	59
2.12	Photograph of TEM (JEOL JEM-2100)	61
2.13	Schematic diagram representing basic mechanism of XRD	65
2.14	Photograph of XRD (D8 Focus, Bruker Ettlingen, Germany)	67
2.15	Schematic Diagram of BET	69
2.16	Photograph of BET (Micromeritics porosity analyser ASAP 1020)	71
2.17	Schematic diagram of solar simulator	75
2.18	Photograph of solar simulator (Sciencetech)	77
2.19	Schematic diagram representing basic circuit of potentiostat	79
2.20	Photograph of potentiostat (Autolab ECO Chemie PGSTAT 30 Potentiostat/Galvanostat)	81
3.1	Schematic representing absorption of photons (a-b) and recombination of charge carriers (c-d) before and after incorporating mesoporous SiO ₂ respectively	87
3.2	Flowchart representing the various steps involved in the synthesis of mesoporous SiO ₂	89
3.3	Flowchart representing the fabrication of DSSCs using single as well as double layer approach	91
3.4	Nitrogen adsorption-desorption isotherms and (inset) pore size distribution	95
3.5	XPS spectra of (a) Si 2p (b) O 1s	97
3.6	(a) SEM of mesoporous SiO ₂ , inset shows the TEM image of mesoporous SiO ₂ (b) SAED pattern (c) HRTEM of mesoporous SiO ₂ particle and (d) magnified view of (c)	99
3.7	Wide angle XRD of mesoporous SiO ₂ in the powder form	101
3.8	UV-Vis spectra of photoanodes (a) reference (b) double layered and (c) single layered	105
3.9	J-V measurement of DSSCs assembled using photoanodes fabricated with different morphologies	107
3.10	Dark current characteristics of DSSC with (a) reference (b) double layered and (c) single layered photoanodes	109
3.11	EIS of (a) reference cell (b) double layered and (c) single layered	111
3.12	Variation of (a) J _{sc} , (b) V _{oc} , (c) FF and (d) η with incorporation of mesoporous SiO ₂ in TiO ₂ electrode	115
3.13	J-V characteristics of DSSCs fabricated using T, 0.5 S, 0.75 S, 1S under 1 sun condition	117

LIST OF FIGURES

3.14 J-V characteristics of DSSCs fabricated under dark conditions . . .	119
3.15 Tauc plots of electrodes T, 0.5 S, 0.75 S and 1 S before dye sensitization	121
3.16 Absorption spectra of dye deloaded from different photoanodes by dipping them in 0.1 M aqueous solution of KOH	123
3.17 Absorption spectra of electrodes T, 0.5 S, 0.75 S and 1 S respectively after dye sensitization, Inset represents the variation of absorption in photoanodes with the wt% of mesoporous SiO ₂	127
3.18 Impedance spectra of DSSCs assembled using T, 0.5 S, 0.75 S and 1S under 1 sun at open circuit voltage	129
3.19 Bode plots for electron lifetime measurements	131
4.1 Schematic diagram of various damping mechanisms of local enhanced field due to SPR in Ag nanoparticles	137
4.2 Schematic representing broadband enhancement in N719 dye using different anisotropic shaped silver nanoparticles	139
4.3 Flowchart representing the steps involved in the synthesis of Ag nanoparticles under different CTAB concentrations (x mM where x=2, 3, 4)	145
4.4 Different magnification TEM images of np-Ag _{pc} (a, b) and np-Ag _{sc} (d, e), their corresponding size histograms (c) and (f)	149
4.5 HRTEM images of single np-Ag _{pc} (a) and np-Ag _{sc} (b), their corresponding SAED patterns (c) and (d)	151
4.6 UV-Vis spectrum of (a) np-Ag _{pc} and (b) np-Ag _{sc} and (Inset) photographs of np-Ag _{pc} and np-Ag _{sc}	153
4.7 Absorption spectra of (a) N719, (b) N719 incorporated with np-Ag _{pc} and (c) N719 incorporated with np-Ag _{sc}	157
4.8 (a) SEM of cross-sectional view of Dye loaded TiO ₂ incorporating Ag nanoparticles (b) Schematic of (a)	159
4.9 Absorption spectra of (a) N719 dye loaded TiO ₂ , (b) TiO ₂ -N719-(np-Ag _{pc}) and (c) TiO ₂ -N719-(np-Ag _{sc})	161
4.10 XRD patterns of CTAB capped Ag nanoparticles using different concentration of surfactant	165
4.11 FTIR spectra of CTAB and Ag nanoparticles synthesized using different CTAB concentrations in (a) higher wavenumber and (b) finger-print region	167

LIST OF FIGURES

4.12	TEM images of Ag nanoparticles synthesized using different CTAB concentrations	169
4.13	Magnified view of TEM images taken at different regions for Ag nanoparticles synthesized with 4 mM CTAB concentration: (a) rod, (b) oval, (c) cube, (d) prism and (e) pentagon shapes (scale bar is 20 nm)	171
4.14	Nano diffraction patterns showing the single crystalline structure of Ag nanoparticles synthesized at CTAB concentration (a) 2 mM and (b) 3 mM respectively, the inset shows corresponding TEM image. The planes from which the electron beam was diffracted to generate the diffraction pattern are indexed in the diffractogram .	175
4.15	Nano diffraction patterns of Ag nanoparticles synthesized at CTAB concentration of 4 mM showing the single crystalline structure for different shapes obtained: (a) rod, (b) oval, (c) cube, (d) prism and (e) pentagon	177
4.16	UV-Vis spectra of (a) Ag nanoparticles synthesized at different CTAB concentrations and (b) shows fitted peaks using Lorentzian distribution for Ag nanoparticles synthesized at CTAB concentration of 4 mM (fitting was done after baseline correction)	179
4.17	UV-Vis spectra of (a) N719 dye incorporated different Ag nanoparticles, the inset shows net changes in absorption of N719 dye (Δ OD) in the presence of Ag nanoparticles	183