Dye Sensitized Solar Cell from Polyaniline-ZnS Nanotubes and its Characterization

through Impedance Spectroscopy

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Synthesis of ZnS nanoparticles (NPs)

Zinc sulphide nanoparticles are synthesized by wet chemical method using zinc acetate $(Zn(Ac)_2 \cdot 2H_2O)$ and sodium sulphide (Na₂S) precursors. In this method, a 0.5 M aqueous ethanol solution (ethanol:water in 3:1 (v/v) ratio) of zinc acetate is kept under constant stirring using magnetic stirrer to dissolve the zinc acetate completely for 2 h and 1.5 M aqueous ethanol solution of sodium sulphide is also prepared in the same way with stirring of 2 h. After complete dissolution of zinc acetate, 1.5 M sodium sulphide solution (aqueous) is added under high speed constant stirring at 65°C, drop by drop (slowly for 1 h). The reaction is allowed to proceed for 2 h after complete addition of sodium sulphide under inert gas atmosphere. After the completion of reaction, the solution is allowed to settle overnight and the supernatant solution is separated carefully. The remained solution is centrifuged for 10 min, and the precipitate is removed. Thus, precipitated ZnS NPs are washed three times with deionized water and ethanol to remove the byproducts which are bound with the nanoparticles and are then dried in air atmosphere at about 60°C.



Fig. S1: FESEM Image of PAZ2



Fig. S2: TEM Image of (a) PAZ1, (b) PAZ2, (c) PAZ6



Element	Peak Area	Weight%	Atomic%
Zn	1670	78.95	51.26
S	676	8.74	11.57
С	277	5.14	18.17
0	443	7.16	19.00

Fig. S3: EDAX Spectra of ZnS NPs



Element	Peak area	Weight%	Atomic%
С	2083	55.19	73.45
Ν	165	6.00	6.84
0	305	7.03	7.03
S	1048	19.33	9.64
Zn	185	12.45	3.04

Fig. S4: EDAX Spectra of PAZ4



Fig. S5: Current-Voltage characteristics of (a) PAZ1, (b) PAZ2, (c) PAZ3 and (d) PAZ4 under dark and illumination condition



Fig. S6: Photocurrent response of (a) PAZ1, (b) PAZ2, (c) PAZ3 composites at different cycles



Fig. S7: J-V characteristics of Pure PANI under AM1.5G light illumination of 100 mW cm⁻²



Fig. S8: J-V characteristics of PAZ4 under AM1.5G light illumination of 100 mW cm⁻² for aging at 40 0 C for different times

Table S1: DSSC characteristics of PAZ4 based solar cell for aging at 40 ° C	for for	different
times		

Time (hr)	Fill factor (FF)	Efficiency,η (%)	Decrease in efficiency (%)	
0	0.55	3.38	-	
6	0.55	3.38	-	
12	0.55	3.38	-	
18	0.55	3.38	-	
24	0.54	3.27	3	
30	0.53	3.22	5	
36	0.49	2.97	12	
42	0.46	2.79	17	
48	0.44	2.69	20	