Electronic Supplementary Material (ESI) for Materials Advances.

Supplementary Data

Table 1: Single dopants data

Sl.No	Papers	Dopants	Treatment/ Coating	Sub Type of doping	Structure	Synthesis Method	Voc (V)	Photocurrent density (mA/cm2)	FF	PCE (%)	Percentage Increase in efficiency due to doping	Bandgap (eV)	Application	Sensitizer Or Dye	Periodic Classification	Reference
1	Improved photovoltaic performance of dye sensitized solar cell by decorating TiO2 photoanode with Li-doped ZnO nanorods	Lithium (Li)		Metal Doping	Nanoparticles	hydrothermal	0.655	9.81	0.358	2.5	362.962963		DSSC	N719	Alkali Metals	[1]
2	Enhanced performance of sodium doped TiO2 nanorods based dye sensitized solar cells sensitized with extract from petals of Hibiscus Sabdariffa (Roselle)	Sodium (Na)		Metal Doping	Nanorods	Hydrothermal	0.55	5.5	0.545	1.65	79.34782609		DSSC	extract from petals of Hibiscus Sabdariffa (Roselle)	Alkali Metals	[2]
3	Enhanced conversion efficiency of dye-sensitized titanium dioxide solar cells by Ca-doping	Calcium (Ca)		Metal Doping	Nanorods	Hydrothermal	0.649	19.2	0.67	8.35	13.9154161		DSSC	N3	Alkaline Earth Metals	[3]
4	Fabrication of un-doped and magnesium doped TiO2 films by aerosol assisted chemical vapor deposition for dye sensitized solar cells	Magnesium (Mg)		Metal Doping	thin films	Aerosol assisted chemical vapor deposition	0.74	11.99	0.67	6.1	81.54761905	2.8	DSSC	N719	Alkaline Earth Metals	[4]
5	Phase change, band gap energy and electrical resistivity of Mg doped TiO2 multilayer thin films for dye sensitized solar cells applications	Magnesium (Mg)		Metal Doping	thin films	Dip coating	0.83	3.02	0.668	1.68		2.98	DSSC	N719	Alkaline Earth Metals	[5]
6	Photovoltaic Performance Improvement of Dye-Sensitized Solar CellsBased on Mg-Doped TiO2Thin Films	Magnesium (Mg)		Metal Doping	Nanoparticles	Hydrothermal	0.615	19.1	0.605	7.12	12.12598425		DSSC	N3	Alkaline Earth Metals	[6]
7	Fabrication of a dye-sensitized	Magnesium		Metal	Nanoparticles	Solvothermal	1.21	1.8	0.55	1.2	66.66666667		DSSC	alkoxysilyl-	Alkaline Earth	[7]

	solar cell containing a Mg-doped TiO2 electrode and a Br3/Br redox mediator with a high open-circuit photovoltage of 1.21 V	(Mg)		Doping									coumarin dye	Metals	
8	Synthesis of magnesium-doped TiO2 photoelectrodes for dyesensitized solar cell applications by solvothermal microwave irradiation method	Magnesium (Mg)		Metal Doping	Nanoparticles	solvothermal microwave irradiation (SMI) technique	0.6435	16.536	0.692	7.36	190.9090909	3.638	DSSC	N3	Alkaline Earth Metals	[8]
9	Improved photovoltaic performance in nano TiO2 based dye sensitized solar cells: Effect of TiCl4 treatment and Sr doping	Strontium (Sr)	TiCl4	Metal Doping	Nanoparticles	Chemical hydrolysis	0.78	18.53	0.66	9.57	249.270073		DSSC	N719	Alkaline Earth Metals	[9]
10	Hydrothermal synthesis of TiO2 nanoparticles doped with trace amounts of strontium, and their application as working electrodes for dye sensitized solar cells: tunable electrical properties & enhanced photo-conversion performance	Strontium (Sr)		Metal Doping	Nanoparticles	hydrothermal	0.728	17.43	0.62	7.88	12.73247496	3.05	DSSC		Alkaline Earth Metals	[10]
11	Improved efficiency of dye-sensitized solar cells through fluorine-doped TiO2 blocking layer	Fluorine (F)		Non-metal Doping	Nanoparticles	hydrolysis	0.67	13.89	0.57	5.24	10.08403361		DSSC	N719	Halogen	[11]
12	Effect of fluorine-doped TiO2 photoanode on electron transport, recombination dynamics and improved DSSC efficiency	Fluorine (F)		Non-metal Doping	Nanocuboids	Hydrothermal	0.603	17.621	0.6984	7.463	62.45102307	3.1	DSSC	N719	Halogen	[12]
13	Improved Utilization of Photogenerated Charge Using Fluorine-Doped TiO2 Hollow	Fluorine (F)		Non metal doping	Hollowspheres	Hydrothermal	0.754	11	0.761	6.31			DSSC		Halogen	[13]

	Spheres Scattering Layer in Dye-Sensitized Solar Cells															
14	Microwave assisted solvothermal synthesis of quasi cubic F doped TiO2 nanostructures and its performance as dye sensitized solar cell photoanode	Fluorine (F)		Non-metal Doping	quasi cubic structures	microwave assisted solvothermal technique	0.745	18.74	0.59	8.2	63.34661355		DSSC	N719	Halogen	[14]
15	Visible-light-response iodine-doped titanium dioxide nanocrystals for dye-sensitized solar cells	Iodine (I)		Non-metal Doping	nanocrystal	Hydrolysis, hydrothermal	0.715	14.1	0.67	7	42.85714286	2.4	DSSC	N3	Halogen	[15]
16	Improved performance of quasi-solid-state dye-sensitized solar cells based on iodine-doped TiO2 spheres photoanodes	Iodine (I)		Non-metal doping	spheres	Hydrothermal, screen printing	0.616	13.81	0.75	6.38	34.03361345		Quasi Solid State DSSC	N719	Halogen	[16]
17	Eu3+ doped down shifting TiO2 layer for efficient dye-sensitized solar cells	Europium (Eu)		Metal Doping	Nanophosphor	Combustion method and Doctor blade	0.67	18.53	0.709	8.8	5.769230769	3.32	DSSC	N719	Lanthanides	[17]
18	Down-converting lanthanide doped TiO2 photoelectrodes for efficiency enhancement of dye-sensitized solar cells	Europium (Eu)		Metal Doping	Nanoparticles	Sol gel, Doctor blade	0.77	9.61	0.69	5.16	21.9858156		DSSC	N719	Lanthanides	[18]
19	Investigation of Gd-doped mesoporous TiO2 spheres for environmental remediation and energy applications	Gadolinium (Gd)		Metal Doping	spheres	Hydrothermal and Spray pyrolysis	0.723	7.749	0.736	4.12	73.83966245		DSSC	N719	Lanthanides	[19]
20	Investigation of Gd-doped mesoporous TiO2 spheres for environmental remediation and energy applications	Gadolinium (Gd)		Metal Doping	Mesoporous	Solvothermal	0.723	7.749	0.736	4.12	42.47572816		DSSC	N719	Lanthanides	[19]
21	Hydrothermal synthesized Nd-doped TiO2 with Anatase and	Neodymium (Nd)		Metal Doping	Anatese	Hydrothermal	0.62	12.83	0.66	5.23	34.1025641	2.6	DSSC	N719	Lanthanides	[20]

	Brookite phases as highly improved photoanode for dye-sensitized solar cell															
22	Vacancies induced enhancement in neodymium doped titania photoanodes based sensitized solar cells and photo-electrochemical cells	Neodymium (Nd)		Metal Doping	Nanoparticles	screen printing method	0.78	11.5	0.683	6.15	13.88888889	3.2655	DSSC	N719	Lanthanides	[21]
23	Enhanced power conversion efficiency of dye-sensitized solar cells with samarium doped TiO2 photoanodes	Samarium (Sm)		Metal Doping	Nanoparticles	hydrothermal	0.863	14	0.5032	6.08	41.44736842		DSSC	N719	Lanthanides	[22]
24	Down-converting lanthanide doped TiO2 photoelectrodes for efficiency enhancement of dye-sensitized solar cells	Samarium (Sm)		Metal Doping	Nanoparticles	Sol gel, Doctor blade	0.81	10.9	0.67	5.81	37.35224586		DSSC	N719	Lanthanides	[18]
25	Improved photovoltaic performance of dye-sensitized solar cells by Sb-doped TiO2 photoanode	Antimony (Sb)		Metal Doping	Nanoparticles	Hydrothermal , Screen Printing	0.635	18.72	0.68	8.13	10.46195652		DSSC	N719	Metalloids	[23]
26	Effects of boron doping in TiO2 nanotubes and the performance of dye-sensitized solar cells	Boron (B)		Metal Doping	Nanotubes	Electrochemical Anodization	0.66	7.85		3.44	13.90728477	3.07	DSSC	N719	Metalloids	[24]
27	Carbonate Doping in TiO2 Microsphere: The Key Parameter Influencing Others for Efficient Dye Sensitized Solar Cell	carbonate		Non metal doping	microsphere	solvothermal	0.76	16.6	0.625	7.65	48.25581395		DSSC	N719	Other Non metals	[25]
28	Enhanced photovoltaic performance of dye-sensitized solar cells (DSSCs) using graphdiyne-doped TiO2 photoanode	Graphidyne (GD)		Non-metal Doping	Nanoparticles	Homocoupling Reaction, Ball milling	0.8	13.73	0.7434	8.03	20.92154421	2.89	DSSC	N719	Other Non metals	[26]
29	A New Strategy on Utilizing Nitrogen	Nitrogen (N)		Non-metal	Nanoparticles	Doctor blade	0.73	18.76	0.58	7.98	17.00879765		DSSC	N719	Other Non metals	[27]

	Doped TiO2 in Nanostructured Solar Cells: Embedded Multifunctional N-TiO2 Scattering Particles in Mesoporous Photoanode			doping												
30	High-Efficiency Electrode Based on Nitrogen-Doped TiO2Nanofibersfor Dye-Sensitized Solar Cells	Nitrogen (N)		Non-Metal Doping	Nanofibre	electrospinning process, hydrothermal treatment	0.75	11.16	0.56	4.7	205.1948052		DSSC	N719	Other Non metals	[28]
31	Mesoscopic nitrogen-doped TiO2 spheres for quantum dot-sensitized solar cells	Nitrogen (N)		Non-metal doping	nano spheres	Hydrothermal and Doctor blade	0.474	12.03	0.64	3.67	71.4953271		QDSSC	CdSe	Other Non metals	[29]
32	Enhanced photocurrent of nitrogen-doped TiO2 film for dye-sensitized solar cells	Nitrogen (N)		Non-metal doping	Nanoparticles	sol-gel	0.726	10.52	0.636	4.86	30.29490617		DSSC	N719	Other Non metals	[30]
33	Nitrogen-doped TiO2 nanoparticles better TiO2 nanotube array photo-anodes for dye sensitized solar cells	Nitrogen (N)		Non-metal doping	Nanotubes	Solvothermal	0.67	8.82	0.4266	2.53	66.44736842		DSSC	N719	Other Non metals	[31]
34	A novel multilayered photoelectrode with nitrogen doped TiO2 for efficiency enhancement in dye sensitized solar cells	Nitrogen (N)		Non-Metal Doping	Nanoparticles	wet chemical method	0.7426	9.52	0.6854	4.84	77.94117647	3.13	DSSC	N719	Other Non metals	[32]
35	Double-N doping: a new discovery about N-doped TiO2 applied in dye-sensitized solar cells	Nitrogen (N)		Non-Metal Doping		wet method, screen printed	0.83	12.4	0.7362	7.58	41.68224299	3.15	DSSC	N719	Other Non metals	[33]
36	Demonstrated photons to electron activity of S-doped TiO2 nanofibers as photoanode in the DSSC	Sulphur (S)		Non-metal Doping	nanofibres	solgel, hydrothermal, electrospinning	0.683	10.66	0.59	4.27	177.2727273		DSSC		Other Non metals	[34]
37	Enhancement of power conversion efficiency of dye sensitized solar cells by modifying	Aluminium (Al)		Metal Doping	mesoporous	chemical bath deposition method	0.705	16.22	0.6677	7.64	10.08645533		DSSC	N719	Post - Transition Metal	[35]

	mesoporous TiO2 photoanode with Al-doped TiO2 layer															
38	Enhancement of power conversion efficiency of dye sensitized solar cells by modifying mesoporous TiO2 photoanode with Al-doped TiO2 layer	Aluminium (Al)		Metal Doping	Nanoparticles	Doctor blade	0.702	16.5	65.75	7.66	9.116809117		DSSC	N719	Post - Transition Metal	[35]
39	Al3+ doping into TiO2 photoanodes improved the performances of amine anchored CdS quantum dot sensitized solar cells	Aluminium (Al)		Metal Doping	Nanoparticles	screen printing method	0.57	11.49	0.318	2.08	45.45454545		QDSSC	CdS/ZnS	Post - Transition Metal	[36]
40	Enhanced open-circuit voltage of dye-sensitized solar cells usingbBi-doped TiO2 nanofibers as working electrode and scattering layer	Bismuth (Bi)		Metal Doping	Nanofibres	Hydrothermal	0.787	14.45	78.2	3.57	63.76		DSSC	N719	Post - Transition Metal	[37]
41	Sol–gel hydrothermal synthesis of bismuth–TiO2 nanocubes for dye-sensitized solar cell	Bismuth (Bi)		Metal Doping	Nanocubes	sol-gel hydrothermal	0.59	7.71	0.46	2.11	77.31092437		DSSC	N3	Post - Transition Metal	[38]
42	Ga3+ and Y3+ Cationic Substitution in Mesoporous TiO2 Photoanodes for Photovoltaic Applications	Gallium (Ga)		Metal Doping	Nanoparticles	Hydrothermal	0.755	13.4	0.79	8.1	9.459459459		DSSC, QDSSC	C101 Ru(+II)	Post - Transition Metal	[39]
43	Photovoltaic efficiency on dye-sensitized solar cells (DSSC) assembled using Ga-incorporated TiO2 materials	Gallium (Ga)		Metal Doping	Nanoparticles	hydrothermal	0.71	12.44	0.51	4.57	45.07658643		DSSC	N3	Post - Transition Metal	[40]
44	Surface modification of TiO2 photoanodes with In3+ using a simple soaking technique for enhancing the efficiency of dye-sensitized solar cells	Indium (In)		Non-Metal Doping	Nanoparticles	simple surface doping technique by immersing TiO2 films with In3+ acidic solution at different soaking time at 70oC followed by sintering at 450oC	0.8	14.33	0.63	7.19	18.06239737		DSSC	C264 triphenylamine dye	Post - Transition Metal	[41]
45	Photovoltaic	Indium (In)		Metal	Nanoparticles	Sol gel, Spin coating	0.735	16.384	0.661	7.96	13.55206847		DSSC	N719	Post -	[42]

	performance improvement of dye-sensitized solar cells through introducing In-doped TiO2 film at conducting glass and mesoporous TiO2 interface as an efficient compact layer			Doping											Transition Metal	
46	Influence of Sn source on the performance of dye-sensitized solar cellsbased on Sn-doped TiO2photoanodes: A strategy for choosing an appropriate doping source	Tin (Sn)		Metal Doping	Nanoparticles	Hydrothermal	0.714	17.14	0.71	8.66	13.79763469		DSSC	N3	Post - Transition Metal	[43]
47	Sn-Doped TiO2 Photoanode for Dye-Sensitized Solar Cells	Tin (Sn)		Metal Doping		hydrothermal	0.722	16.01	0.707	8.31	11.54362416		DSSC	N3	Post - Transition Metal	[44]
48	Zirconium oxide post treated tin doped TiO2 for dye sensitized solar cells	Tin (Sn)	Post treated with Zr and HNO3	Metal Doping	Nanorods	solgel, hydrothermal	0.749	9.81	0.674	4.96		2.99	DSSC	N719	Post - Transition Metal	[45]
49	Zirconium oxide post treated tin doped TiO2 for dye sensitized solar cells	Tin (Sn)	Post treated with Zr and HNO4	Metal Doping	Nanorods	solgel, hydrothermal	0.747	5.21	0.534	2.09		2.99	DSSC	leaves of Camelllia sinensis	Post - Transition Metal	[45]
50	Evaluation of surface energy state distribution and bulk defectconcentration in DSSC photoanodes based on Sn, Fe, and Cudoped TiO	Tin (Sn)		Metal Doping	Nanoparticles	Solgel, Hydrothermal	0.76	12.76	0.577	6.24	6.12244898	3.27	DSSC	N719	Post - Transition Metal	[46]
51	Improved performance of dye-sensitized solar cells by trace amount Cr-doped TiO2 photoelectrodes	Chromium (Cr)		Metal Doping	Nanoparticles	Hydrothermal and Doctor blade	0.705	11.34	0.69	6.35	14.62093863		DSSC	N719	Transition Metal	[47]
52	Physicochemical properties of Cr-doped TiO2 nanotubes and their application in dye-sensitized solar cells	Chromium (Cr)		Metal Doping	Bilayer, NP, Nanotubes	Microwave assisted hydrothermal	0.69	18.75	0.66	8.69	47.78911565		DSSC	N719	Transition Metal	[48]
53	Cr-doped TiO2	Chromium		Metal	Nanoparticles,	Microwave assisted	0.69	26.29	0.6	11.05	22.09944751		DSSC	N719	Transition	[49]

	nanotubes with a double-layer model: An effective way to improve the efficiency of dye-sensitized solar cells	(Cr)		Doping	Nanotubes	hydrothermal									Metal	
54	Controlling electron injection and electron transport of dye-sensitized solar cells aided by incorporating CNTs into a Cr-doped TiO2 photoanode	Chromium (Cr)		Metal Doping	Nanoparticles, Nanotubes	Sol gel, Spin coating	6.98	17.54	0.609	7.47	44.76744186		DSSC	N719	Transition Metal	[50]
55	Incorporation of Mn2+ and Co2+ to TiO2 nanoparticles and the performance of dye-sensitized solar cells	Cobalt (Co)		Metal Doping	Nanoparticles	Hydrothermal, Doctor blade	0.6	3.12	0.571	1.06	-79.88614801		DSSC	N719	Transition Metal	[51]
56	The effects of metal doped TiO2 and dithizone-metal complexes on DSSCs performance	Cobalt (Co)		Metal Doping	Nanoparticles	microwave assisted hydrothermal method	1.201	6.87	0.59	4.85	8.744394619		DSSC	N719	Transition Metal	[52]
57	Synthesis, characterization and application of Co doped TiO2 multilayer thin films	Cobalt (Co)		Metal Doping	Brookite	Spray Pyrolysis	0.87	11.04	0.59	5.66		3.3	DSSC	N719	Transition Metal	[53]
58	Plasmonic copper nanowire@TiO2 nanostructures for improving the performance of dye-sensitized solar cells	Copper (Cu)		Metal Doping	Core shell nanostructure, nanowires	Doctor blade	0.75	18.26	0.68	9.44	23.39869281		DSSC	N719	Transition Metal	[54]
59	Synthesis of two-dimensional nanowall of Cu-Doped TiO2 and its application as photoanode in DSSCs	Copper (Cu)		Metal Doping	nanowall	Liquid phase deposition method	0.64	1.8	0.0038	0.44	120	3.32	DSSC	N719	Transition Metal	[55]
60	Microwave-assisted hydrothermal synthesis of Cu-doped TiO2 nanoparticles for efficient dye-sensitized solar cell with improved open-circuit	Copper (Cu)		Metal Doping	Nanoparticles	Microwave assisted hydrothermal	0.762	13.2	0.689	6.94	19.44922547	2.96	DSSC	N719	Transition Metal	[56]

	voltage															
61	Effect of Cu and Mn amounts doped to TiO2 on the performance of DSSCs	Copper (Cu)		Metal Doping	Nanoparticles	Microwave assisted hydrothermal	1.073	7.34	0.65	5.09	6.708595388		DSSC	N719	Transition Metal	[57]
62	Surface plasmon resonance effect of Cu nanoparticles in a dye sensitized solar cell	Copper (Cu)		Metal Doping	Nanoparticles	sol-gel	0.71	18.8	0.642	8.65	34.94539782	2.7	DSSC	N719	Transition Metal	[58]
63	Evaluation of surface energy state distribution and bulk defectconcentration in DSSC photoanodes based on Sn, Fe, and Cudoped TiO	Copper (Cu)		Metal Doping	Nanoparticles	Solgel, Hydrothermal	0.76	10.68	0.585	5.24	-10.88435374	3.23	DSSC	N719	Transition Metal	[46]
64	Facile synthesis of Au@TiO2 core–shell hollow spheres for dye-sensitized solar cells with remarkably improved efficiency	Gold (Au)		Metal Doping	Thin shell, hollow sub-microspheres	hydrothermal method	0.63	22.1	0.64	8.13	15.15580737		DSSC	N719	Transition Metal	[59]
65	Au/TiO2 Hollow Spheres with Synergistic Effect of Plasmonic Enhancement and Light Scattering for Improved Dye-Sensitized Solar Cells	Gold (Au)		Metal Doping	Nanoparticles		0.7	0.7	0.5611	6.51			DSSC	N719	Transition Metal	[60]
66	The effects of metal doped TiO2 and dithizone-metal complexes on DSSCs performance	Iron (Fe)		Metal Doping	Nanoparticles	microwave assisted hydrothermal method	0.939	8.37	0.35	2.74	-38.56502242		DSSC	N719	Transition Metal	[52]
67	Synthesis, characterization, and application of transition metals (Ni, Zr, and Fe) doped TiO2 photoelectrodes for dye-sensitized solar cells	Iron (Fe)		Metal Doping	Nanoparticle	sol-gel	0.29	0.22	0.0027	0.017	-10.52631579	3.13	DSSC	N719	Transition Metal	[61]
68	Evaluation of surface energy state distribution and bulk defectconcentration in DSSC photoanodes based	Iron (Fe)		Metal Doping	Nanoparticles	Solgel, Hydrothermal	0.71	1.14	0.731	0.67	-88.60544218	3.24	DSSC	N719	Transition Metal	[46]

	on Sn, Fe, and Cudoped TiO															
69	Incorporation of Mn2+ and Co2+ to TiO2 nanoparticles and the performance of dye-sensitized solar cells	Manganese (Mn)		Metal Doping	Nanoparticles	Hydrothermal, Doctor blade	0.656	4.241	0.667	1.85	-64.89563567		DSSC	N719	Transition Metal	[51]
70		Manganese (Mn)		Metal Doping	Nanoparticles	Microwave assisted hydrothermal	1.181	7.52	0.55	4.87	2.096436059		DSSC	N719	Transition Metal	[57]
71	The effects of metal doped TiO2 and dithizone-metal complexes on DSSCs performance	Nickel (Ni)		Metal Doping	Nanoparticles	microwave assisted hydrothermal method	1.126	7.75	0.51	4.47	0.2242152466		DSSC	N719	Transition Metal	[52]
72	Synthesis, characterization, and application of transition metals (Ni, Zr, and Fe) doped TiO2 photoelectrodes for dye-sensitized solar cells	Nickel (Ni)		Metal Doping	Nanoparticle	sol-gel	0.31	0.17	0.0029	0.015	-21.05263158	3.15	DSSC	N719	Transition Metal	[61]
73	Niobium doped TiO2 nanorod arrays as efficient electron transport material in photovoltaic	Niobium (Nb)		Metal Doping	Nanorods	Electrochemical Anodization	0.615	14.43	0.583	5.17	33.24742268	2.8	DSSC	N719	Transition Metal	[62]
74	Influence of Nb-doped TiO2 blocking layers as a cascading band structure for enhanced photovoltaic properties	Niobium (Nb)		Metal Doping	Nanoparticles	horizontal ultrasonic spray pyrolysis deposition (HUSPD)	0.74	16.9	0.6026	7.5	4.748603352		DSSC	N719	Transition Metal	[63]
75	Improved-Performance Dye-Sensitized Solar Cells Using Nb-Doped TiO2 Electrodes: Efficient Electron Injection and Transfer	Niobium (Nb)		Metal Doping	Nanoparticles	Hydrothermal	0.7	17.67	0.63	7.8	18.18181818		DSSC	N719	Transition Metal	[64]
76	The Synthesis of Nb-doped TiO2 Nanoparticles for Improved-Performance Dye Sensitized Solar Cells	Niobium (Nb)		Metal Doping	Nanoparticles	Hydrothermal	0.742	15.907	0.717	8.459	19.78193146		DSSC	N719	Transition Metal	[65]
77	Influence of VB group doped TiO2 on photovoltaic performance of	Niobium (Nb)		Metal Doping	Nanoparticles	hydrothermal	0.685	18.9	0.64	8.33	12.26415094		DSSC	N3	Transition Metal	[66]

	dye-sensitized solar cells															
78	Fabrication and Photovoltaic Performance of Niobium Doped TiO2 Hierarchical Microspheres with Exposed {001} Facets and High Specific Surface Area	Niobium (Nb)		Metal Doping	porous microspheres	hydrothermal method followed by heat treatment	0.599	14.5	0.575	4.99	13.66742597		DSSC	N719	Transition Metal	[67]
79	The Synthesis of Nb-doped TiO2 Nanoparticles for Improved-Performance Dye Sensitized Solar Cells	Niobium (Nb)		Metal Doping	Nanoparticles	Hydrothermal synthesis and Screen Printing	0.742	15.907	0.717	8.459	19.78193146		DSSC	N719	Transition Metal	[65]
80	Efficiency Enhancement of Dye-Sensitized Solar Cells Using Ti–Nb Alloy Photoanodes with Mesoporous Oxide Surface	Niobium (Nb)		Metal Doping	Nanoparticles	Screen Printing	0.74	7.26	0.76	4.14	16.29213483		DSSC	N719	Transition Metal	[68]
81	Electronic structure study of lightly Nb-doped TiO2 electrode for dye-sensitized solar cells	Niobium (Nb)		Metal Doping	Nanoparticles	sol-gel, co-hydrolysis, hydrothermal treatment	0.73	16.32	0.68	8	17.64705882	3.12	DSSC	N719	Transition Metal	[69]
82	Titanium mesh supported TiO2 nanowire arrays/Nb-doped TiO2 nanoparticles for fully flexible dye-sensitized solar cells with improved photovoltaic property	Niobium (Nb)		Metal Doping	Nanoarrays, nanoparticles	two-step hydrothermal, spin-coating approach	0.78	13.6	0.68	7.2	45.16129032		DSSC	N719	Transition Metal	[70]
83	Efficiency Improvement of DSSC Photoanode by Scandium Doping of Mesoporous Titania Beads	Scandium (Sc)		Metal Doping	mesoporous beads/nanoparticles	controlled hydrolysis	0.752	19.1	0.675	9.6	6.666666667		DSSC	N719	Transition Metal	[71]
84	Ag nanoparticle-decorated 3D flower-like TiO2 hierarchical microstructures composed of ultrathin nanosheets and enhanced photoelectrical	Silver (Ag)		Metal Doping	3D flower like microstructures	Hydrothermal, photoreduction method	0.72	25.88	0.49	8.98	44.37299035		DSSC	N719	Transition Metal	[72]

	conversion properties in dye-sensitized solar cells															
85	Dye-sensitized solar cells enhanced by optical absorption, mediatedby TiO2 nanofibers and plasmonics Ag nanoparticles	Silver (Ag)		Metal Doping	Nanoparticles	polyol, electrospinning	0.764	11.88	0.685	6.23	17.76937618		DSSC	N719	Transition Metal	[73]
86	Dye-sensitized solar cells enhanced by optical absorption, mediatedby TiO2 nanofibers and plasmonics Ag nanoparticles	Silver (Ag)		Metal Doping	Nanoparticles, Nanofibres	polyol, electrospinning	0.752	13.68	0.685	7.05	-1.260504202		DSSC	N719	Transition Metal	[73]
87	Systematic characterization of the effect of Ag@TiO2 nanoparticles on the performance of plasmonic dye sensitized solar cells	Silver (Ag)		Metal Doping	Nanoparticles	Sol process	0.744	8.93	0.591	5	7.296137339		DSSC	N719	Transition Metal	[74]
88	Effect of Ag-doped TiO2 thin film passive layers on the performance of photo-anodes for dye-sensitized solar cells	Silver (Ag)	Ag coating	Metal Doping	Nanoparticles		0.71	4.24	0.62				DSSC	N719	Transition Metal	[75]
89	Atomic Layer Deposition of Ta-doped TiO2 Electrodes for Dye-Sensitized Solar Cells	Tantalum (Ta)		Metal Doping	Nanoparticles	atomic layer deposition	0.71	3.69	0.6	1.56	21.875		DSSC	N719	Transition Metal	[76]
90	Influence of VB group doped TiO2 on photovoltaic performance of dye-sensitized solar cells	Tantalum (Ta)		Metal Doping	Nanoparticles	hydrothermal	0.665	19.7	0.65	8.18	10.2425876		DSSC	N3	Transition Metal	[66]
91	Photovoltaic performance improvement of dye-sensitized solar cells based on tantalum-doped TiO2 thin films	Tantalum (Ta)		Metal Doping	Nanoparticles	hydrothermal	0.665	19.1	0.65	8.18	10.54054054		DSSC	N3	Transition Metal	[77]
92	Increasing Photocurrents in Dye Sensitized Solar Cells with Tantalum-Doped	Tantalum (Ta)		Metal Doping	Nanoparticles	Laser Ablation	0.69	15.9	0.61	6.7	39.58333333		DSSC	N719	Transition Metal	[78]

	Titanium Oxide Photoanodes Obtained by Laser Ablation															
93	Ta-doped hierarchical TiO2 spheres for dye-sensitized solar cells	Tantalum (Ta)		Metal Doping	nano spheres	screen printing method	0.663	13.89	0.77	7.1	30.99630996		DSSC	N719	Transition Metal	[79]
94	Dye-Sensitized W-Doped TiO2 Solar Cells with a Tunable Conduction Band and Suppressed Charge Recombination	Tungsten (W)		Metal Doping	Nanoparticles	Modified Solgel Method	0.61	8.94	0.77	4.2	19.76190476		DSSC	A new coumarin dye	Transition Metal	[80]
95	Influence of VB group doped TiO2 on photovoltaic performance of dye-sensitized solar cells	Vanadium (V)		Metal Doping	Nanoparticles	hydrothermal	0.687	17.6	0.65	7.8	5.121293801		DSSC	N3	Transition Metal	[66]
96	Influence of yttrium dopant on the properties of anatase nanoparticles and the performance of dye-sensitized solar cells	Yttrium (Y)		Metal Doping	Nanoparticles	Gel-sol	0.706	15.74	0.6846	7.61	19.97371879		DSSC	N719	Transition Metal	[81]
97	Ga3+ and Y3+ Cationic Substitution in Mesoporous TiO2 Photoanodes for Photovoltaic Applications	Yttrium (Y)		Metal Doping	Nanoparticles	Hydrothermal	0.739	15.9	0.77	9	21.62162162		DSSC, QDSSC	C101 Ru(+II)	Transition Metal	[39]
98	Yttrium doped TiO2 porous film photoanode for dye-sensitized solar cells with enhanced photovoltaic performance	Yttrium (Y)		Metal Doping	Nanoparticles	hydrothermal	0.81	23.9	0.4724	9.18	21.78649237		DSSC	N719	Transition Metal	[82]
99	Porous Zn-doped TiO2 nanowall photoanode: Effect of Zn2+ concentration on the dye-sensitized solar cell performance	Zinc (Zn)		Metal Doping	Nanowall	Liquid phase deposition method	0.66	10.68	0.28	1.98			DSSC	N719	Transition Metal	[83]
100	The effects of metal doped TiO2 and dithizone-metal complexes on DSSCs performance	Zinc (Zn)		Metal Doping	Nanoparticles	microwave assisted hydrothermal method	1.097	7.85	0.52	4.49	0.6726457399		DSSC	N719	Transition Metal	[52]

101	300 keV cobalt ions irradiations effect on the structural, morphological, optical and photovolatic properties of Zn doped TiO2 thin films based dye sensitized solar cells	Zinc (Zn), Cobalt (Co)		Metal Doping		sol-gel	0.72	6.44	0.82	3.78	266.9902913	2.9	DSSC	N719	Transition Metal	[84]
102	Alternative route for the preparation of Zr-doped TiO2 layers for energy and environmental applications	Zirconium (Zr)		Metal Doping		ball milling, dissolving, impregnation, mixing, screen printing	0.7067	10.527	0.75	5.42	-1.454545455		DSSC	N719	Transition Metal	[85]
103	Efficient dye-sensitized solar cells based on CNTs and Zr-doped TiO2 nanoparticles	Zirconium (Zr)		Metal Doping	Nanoparticles	sol-gel	0.712	15.5	0.626	6.81	10.37277147	3.1	DSSC	N719	Transition Metal	[86]
104	Efficient dye-sensitized solar cells based on CNTs and Zr-doped TiO2 nanoparticles	Zirconium (Zr)	CNT coating	Metal Doping	Nanoparticles	sol-gel	0.699	19.4	0.602	8.19	32.73905997		DSSC	N719	Transition Metal	[86]
105	Synthesis, characterization, and application of transition metals (Ni, Zr, and Fe) doped TiO2 photoelectrodes for dye-sensitized solar cells	Zirconium (Zr)		Metal Doping	Nanoparticle	sol-gel	0.45	0.13	0.0034	0.02	5.263157895	3.09	DSSC	N719	Transition Metal	[61]
106	Efficiency enhancement of dye-sensitized solar cells by use of ZrO2-doped TiO2 nanofibers photoanode	Zirconium (Zr)		Metal Doping	Nano fiber	solgel, electrospinning	0.82	7.74	0.71	4.51	180.1242236	3.22	DSSC	N719	Transition Metal	[87]

Table 2: Co dopants Data

	Papers	Dopants	Sub Type of doping	Structure	Synthesis Method	Voc (V)	Photocurrent density (mA/cm2)	FF	PCE (%)	Increase in PCE	Percentage Increase in efficiency due to doping	Bandgap (eV)	Application	Sensitizer Or Dye	Reference
1	Novel synergistic combination of Cu/S co-doped TiO2 nanoparticles incorporated as photoanode in dye sensitized solar cell	Copper(Cu), Suphur (S)	Metal-Non metal	Nano particles	Sol gel	0.71	22.05	0.6668	10.44	4.07	63.89324961	2.86	DSSC	N719	[88]
2	Novel synergistic combination of Al/N Co-doped TiO2 nanoparticles for highly efficient dye-sensitized solar cells	Aluminium(Al), Nitrogen (N)	Metal -Non metal	Nano particles	Sol gel	0.715	22.22	0.667	11.08	3.21	40.78780178	2.7	DSSC	N719	[89]
3	A novel sulfur source for biosynthesis of (Ag,S) - modified TiO2 photoanodes in DSSC	Silver(Ag), Sulphur (S)	Metal - Non metal	Nano particles	wet impregnation method	0.736	12.3	0.522	4.73	1.01	27.15053763		DSSC	N719	[90]
4	Effect of Nickele Zinc Co-doped TiO2 blocking layer on performance of DSSCs	Nickel(Ni),Zinc (Zn)	Metal - Metal	Nano particles	Spin coating	0.694	1.436	0.459	0.76	0.29	61.70212766	3.78	DSSC	mercurochrome (MC) dye	[91]
5	La modified TiO2 photoanode and its effect on DSSC performance: A comparative study of doping and surface treatment on	Magnesium(Mg), Lanthanum (La)	Metal - Metal	Nano particles	solgel, surface treated by ball milling	0.78	11.1	0.634	6.1	1.7	38.63636364		DSSC	N719	[92]

	deep and surface charge trapping														
6	Enhanced efficiency of dye-sensitized solar cells based on Mg and La co-doped TiO2 photoanodes	Magnesium(Mg), Lanthanum (La)	Metal - Metal	Nano particles	Sol gel	0.743	14.2	0.687	8	1.3	19.40298507		DSSC	N719	[93]
7	Zn and Sr co-doped TiO2 mesoporous nanospheres as photoanodes in dye sensitized solar cell	Zinc(Zn), Strontium (Sr)	Metal - Metal	mesoporous nanospheres	Solgel, solvothermal	0.72	8.63	0.73	4.6				DSSC	N719	[94]
8	Nitrogen doped TiO2/Graphene nanofibers as DSSCs photoanode	Nitrogen (N), Graphene (G)	Non Metal - Non Metal	Nanofibres	Electrospinning, hydrothermal	0.71	15.38	0.46	5.01			3.2	DSSC	N719	[95]
9	Improving Energy Conversion Efficiency of Dye-Sensitized Solar Cells by Modifying TiO2 Photoanodes with Nitrogen-Reduced Graphene Oxide	Nitrogen (N), reduced Graphene oxide (rGO)	Non Metal - Non Metal	Nano particles	Hummers method, solvothermal reduction	0.722	18.74	0.5308	7.19	0.84	13.22834646		DSSC	N3	[96]
10	Enhancing the Efficiency of DSSCs by the Modification of TiO2 Photoanodes using N, F and S, co-doped Graphene Quantum Dots	Nitrogen, Fluorine, Sulphur, Graphene Quantum Dots (NFS-GQDs)	Multi elemental doping	Nano particles		0.79	22.6	0.7	11.7	4.22	56.4171123		DSSC	N719	[97]
11	Boron and Sulfur co-doped TiO2 nanofilm as effective photoanode for	Boron (B), Sulfur (S)	Non metal - Non metal	Nano particles	Chemical Bath Deposition	1.217	3.35	0.882	3.6	0.39	12.14953271		QDSSC	CdS QD	[98]

	high efficiency CdS QDSSC														
12	Copper and nitrogen doping on TiO2 photoelectrodes and their functions in dye sensitized solar cells	Copper (Cu), Nitrogen (N)	Metal -Non Metal	Nano particles	Sol gel	0.7	22.55	0.655	11.35	1.82	19.09758657	2.91	DSSC	N719	[99]
13	Er3+ and Yb3+ co-doped TiO2xFx up-conversion luminescence powder as a light scattering layer with enhanced performance in dye sensitized solar cells	Erbium (Er), Ytterbium (Yb)	Metal - Metal doping	Nano particles	Hydrothermal and Screen printing	0.725	16.3	0.6	7.08	1.68	31.11111111		DSSC	N719	[56]
14	Improved photovoltaic performance of dye-sensitized solar cells (DSSCs) by Zn + Mg co-doped TiO2 electrode	Zinc(Zn), Magnesium (Mg)	Metal - Metal	Nano particles	Hydrothermal , Doctor blade	0.625	20.1	0.73	9.07	1.91	26.67597765		DSSC	N3	[100]
15	Investigations on the efficiency variation of zinc and gallium Co-doped TiO2 based dye sensitized solar cells	Zinc(Zn), Gallium (Ga)	Metal/Metal doping	Thin films	Sol gel and Dip coating	0.86	7.24	0.7	4.36	3.1	246.031746	3.2	DSSC	N719	[101]
16	N-I co-doped TiO2 compact film as a highly effective n-type electron blocking layer for solar cells	Nitrogen(N), Iodine (I)	Non-Metal/Non-Metal doping	Nano particles	Screen printing method	0.733	14.23	0.65	6.79	1.02	11.12929624		DSSC	N719	[102]
17	Europium and terbium lanthanide ions co-doping in TiO2	Europium (Eu),Terbium (Tb)	Metal-Metal	Nano powders	Sol gel and Doctor Blade	0.744	19.03	0.64	9.11	1.91	26.52777778		DSSC	N719	[103]

	photoanode to synchronously improve light-harvesting and open-circuit voltage for high efficiency dye-sensitized solar cells														
18	Effects of ionic radii of co-dopants (Mg, Ca, Al and La) in TiO2 on performance of dye-sensitized solar cells	Magnesium - Lanthanum (Mg-La)	Metal - Metal	Nano particles	Sol gel and Doctor Blade	0.76	11.35	0.686	6.6	1.33	25.23719165	3.25	DSSC	N719	[104]
18		Calcium-Lanthanum (Ca -La)	Metal - Metal	Nano particles	Sol gel and Doctor Blade	0.69	11.73	0.696	6.28	1.01	19.16508539	3.25	DSSC	N719	[104]
18		Aluminium - Lanthanum (Al- La)	Metal - Metal	Nano particles	Sol gel and Doctor Blade	0.69	4.66	0.72	2.57	-2.7	-51.23339658	3.25	DSSC	N719	[104]
19	Niobium and iron co-doped titania nanobelts for improving charge collection in dye-sensitized TiO2 solar cells	Niobium - Iron (Nb-Fe)	Metal - Metal	Nano belts, Nano particles	Hydrothermal , Screen Printing			0.69	3.78	0.93	32.63157895		DSSC	N719	[105]
20	Effects of multi-element dopants of TiO2 for high performance in dye-sensitized solar cells	Boron (B), Carbon (C), Nitrogen(N), Fluorine (F)	Multi elemental	Nano particles	Paint shaking method, Screen printing	0.897	9.737	0.662	5.785	-3.046	-34.49213		DSSC	(Ruthenium535-bis TBA	[106]
21	Mesoporous (N, S)-codoped TiO2 nanoparticles as effective photoanode for dye-sensitized solar cells	Nitrogen(N), Sulfur (S)	Non-metal-Non-metal	Nano particles	Hydrothermal, Doctor blade	0.82	18.2	0.462	6.9	1	16.94915254		DSSC	N719	[107]
22	Improved efficiency of dye-sensitized solar cells applied with nanostructured	Nitrogen(N), Sulfur (S)	Non-metal-Non-metal	Nano particles	Hydrothermal, Doctor blade	0.654	21.18	0.62	8.61	1.26	17.14285714	3.2	DSSC	N3	[108]

	N–F doped TiO2 electrode														
23	N, La Co-Doped TiO2 for Use in Low-Temperature-Based Dye-Sensitized Solar Cells	Nitrogen (N), Lanthanum (La)	Metal-Non-metal	Nano particles	Sol gel	0.72778	10.518	0.69582	5.33	1.31	32.58706468	2.83	DSSC	N719	[109]
24	Nitrogen and yttrium co-doped mesoporous titania photoanodes applied in DSSCs	Nitrogen (N), Yttrium (Y)	Metal-Non-metal	Nano particles	Sol gel	0.735	10.76	0.684	5.41	0.83	18.12227074		DSSC	N719	[110]
25	Hydrothermal synthesis of Fe- and Nb-doped titania nanobelts and their tunable electronic structure toward photovoltaic application	Niobium (Nb), Iron (Fe)	Metal-Metal	Nano belts	Hydrothermal			0.65	1.81	0.25	16.02564103	3.08	DSSC	N719	[111]
26	Enhanced short circuit current density of dye-sensitized solar cells aided by Sr,V co-doped TiO2 particles	Strontium(Sr), Vanadium (V)	Metal-Metal	Nano particles	Modified Sol gel	0.68792	18.57	0.6181	7.76	1.62	26.38436482	2.57	DSSC	N719	[112]
27	Enhanced performance of dye-sensitized solar cells aided by Sr,Cr co-doped TiO2 xerogel films made of uniform spheres	Strontium(Sr), Chromium (Cr)	Metal-Metal	Nano particles	Modified Sol gel	0.69773	18.58	0.6117	7.89	1.75	28.50162866	2.56	DSSC	N719	[113]
28	Dual functions of YF3:Eu31 for improving photovoltaic performance of dye-sensitized	Yttrium, Fluorine, Europium (YFEu)	Metal-Non metal-metal (Tri doping)		Hydrothermal	0.787	14.894	0.661	7.741	1.9	32.5286766		DSSC	N719	[114]

	solar cells														
29	Metal and F dual-doping to synchronously improve electronic transport rate and lifetime for TiO2 photoanode to enhance dye-sensitized solar cells performances	Tin(Sn), Fluorine (F)	Metal -Non metal	Nano particles	Hydrothermal	0.725	17.03	0.72	8.89	1.67	23.13019391		DSSC	N719	[115]
30	Boosting Photovoltaic Performance of Dye-Sensitized Solar Cells Using Silver Nanoparticle-Decorated N,S-Co- Doped-TiO2 Photoanode	Nitrogen(N),Sulphur (S)	Non-meta/Non-metal	Nano particles	Chemical reduction method	0.69	9.78	0.5	3.35	0.78	30.35019455	3.2	DSSC	N719	[116]
31	Enhancement of dye-sensitized solar cells using Zr/N-doped TiO2 composites as photoelectrodes	Zirconium(Zr), Nitrogen (N)	Metal,Non-metal	Nano particles	Sol gel	0.742	14.48	0.686	8.25	5.65	219.844358	2.83	DSSC	N719	[117]
32	N, S-doped TiO2 anode effect on performance of dye-sensitized solar cells	Nitrogen(N), Sulphur (S)	Non-metal-Non-metal	Nano particles		0.737	9.37	0.536	3.7	3	57.14285714		DSSC	P3DT, N719	[118]
33	Synthesis and Up-Conversion Properties of Ho3+-Yb3+-F− Tri-Doped TiO2 Nanoparticles and their Application in Dye-Sensitized Solar Cells	Holmium (Ho), Ytterbium (Yb), Flourine (F)	Metal, Metal, Non metal (Tri doping)	Nano particles	Hydrosol Hydrothermal , Screen print	0.73	13.46	0.54	5.31	0.38	14.90196078				[119]
34	Essential role of N and Au on	Gold(Au), Nitrogen	Metal , Non	Nano	Chemical reduction	0.69	22.42	0.51	7.9	5.35	209.8039216		DSSC	N719	[120]

	TiO2 as photoanode for efficient dye-sensitized solar cel	(N)	metal	particles	method										

Table 3: Composite Doping

	Papers	**Treatment/ Coating**	**Composite**	**Structure**	**Synthesis Method**	**Voc (V)**	**Photocurrent density (mA/cm2)**	**FF**	**PCE (%)**	**Percentage Increase in efficiency due to doping**	**Bandgap (eV)**	**Application**	**Sensitizer Or Dye**	**Reference**
1	Interface Engineering through Atomic Layer Deposition towards Highly Improved Performance of Dye-Sensitized Solar Cells		ZnO nanobelts, P25 TiO2 nanoparticles	Nano belts, Nano particles	Solution reaction process, ALD technique	0.74	9.67	0.65	4.68	61.37931034		DSSC	N719	[121]
2	Enhanced photoelectric conversion efficiency of dye sensitized solar cells by the incorporation of flower-like Bi2S3:Eu3+ sub-microspheres		Bi2S3:Eu3+	Flower like nanocrystal	Hydrothermal	0.727	16.0667	0.65	7.47	7.482014388		DSSC	N719	[122]
3	Aromatic amine passivated TiO2 for dye-sensitized solar cells (DSSC) with ~9.8% efficiency	aniline capped TiO2	Aniline, TiO2	Nano particles	Hydrothermal	0.766	17.44	0.7	9.48	5.921787709		DSSC	N719	[123]
4	Enhanced Properties of Dye-Sensitized Solar Cells by Surface Plasmon Resonance of Ag Nanowires core-shell structure in TiO2 films	Coated with SiO2	Silver Nanowire, TiO2	Nano wire	liquid-solution-phase reduction approach, Ball milling	0.708	11.83	0.63	6.26	14.86238532		DSSC	N719	[124]
5	Synergistics of Cr(III) doping in TiO2/MWCNTs nanocomposites: Their		Cr(III)MWCNT	Nanotubes	Solgel	0.67	16.887	0.5463	6.18	306.5789474	2.89	DSSC	N719	[125]

	enhanced physicochemical properties in relation to photovoltaic studies													
6	A novel, PbS quantum dot-Sensitized solar cell structure with TiO2-fMWCNTS nano-composite filled meso-porous anatase TiO2 photoanode	functionalized Multiwall Carbon Nanotubes (fwcnt)		Nanotubes	Ball milling and Doctor blade	0.65	15.8	0.55	5.6		2	QDSSC	PbS(20 Cycle)	[126]
7	Enhanced efficiency of quantum dot sensitized solar cells using Cu2O/TiO2 nanocomposite photoanodes		TiO2/CdS/ZnS/Cu2O	Nanoparticles	Wet impregnation method,Doctor Blade	0.55	8.4	0.44	3.01	157.2649573	3.08	QDSSC	CdS	[127]
8	Carbon nitride doped TiO2 photoelectrodes for photocatalysts and quantum dot sensitized solar cells		C3N4-TiO2	Nano particles	Screen Printing	0.526	10.99	0.503	2.91	29.33333333		QDSSC		[128]
9	Enhanced photon collection of high surface area carbonate-doped mesoporous TiO2 nanospheres for dye sensitized solar cells applications		Carbonate group	Nanospheres	Spray coating	0.73	12.16	0.61	5.4	58.82352941		DSSC	N719	[129]
10	TiO2–Au plasmonic nanocomposite for enhanced dye-sensitized solar cell (DSSC) performance		TiO2 , Gold(Au)	Nanospheres	Hydrothermal	0.74	13.2	0.61	6	20		DSSC	N719	[130]
11	Preparation of the Au@TiO2 nanofibers by one-step electrospinning for the composite photoanode of dye-sensitized solar cells		TiO2 , Gold(Au)	Nano fiber	Electrospinning	0.76	10.07	0.67	5.08	7.399577167		DSSC	N719	[131]
12	Gold nanoparticle decorated carbon nanotube nanocomposite for dye-sensitized solar cell performance and stability enhancement		Gold (Au) multi walled carbon nanotubes (MWCNT)	Nano particles	Site specific deposition by chemical bond	0.733	12.71	0.71	6.61	29.86247544		DSSC	N719	[132]
13	Reduced interfacial recombination in dye-sensitized solar cells assisted with NiO:Eu3+,Tb3+ coated TiO2 film		Nickel Oxide (NiO)		Sol-gel, doctor blade	0.77	16.18	0.63	7.81	26.5802269				[133]
			TiO2/NiO: Eu3+,Tb3+		Sol-gel, doctor blade	0.78	17.4	0.65	8.8	42.62560778		DSSC	N719	133]
14	Boosting Photovoltaic Performance of Dye-Sensitized Solar Cells		Silver particle decorated and doped with Nitrogen(N), Sulphur (S)	Nano particles	Chemical reduction method	0.77	29.05	0.37	8.22	219.844358	2.9	DSSC	N719	[134]

	Using Silver Nanoparticle-Decorated N,S-Co- Doped-TiO2 Photoanode													
15	Carbonate Doping in TiO2 Microsphere: The Key Parameter Influencing Others for Efficient Dye Sensitized Solar Cell	carbonate		microsphere		0.76	16.6	0.625	7.65	48.25581395		DSSC	N719	[25]

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