

Supplementary Information (SI)

Hole transfer materials mediating hole transfer for high efficiency quantum dot sensitized solar cells

Yu Lin, Han Song, Jianxin Zhang, Huashang Rao, Zhenxiao Pan,* and Xinhua Zhong*

Key Laboratory for Biobased Materials and Energy of Ministry of Education, College of Materials and Energy, South China Agricultural University, Guangzhou 510642, China

Guangdong Laboratory for Lingnan Modern Agriculture, Guangzhou 510642, China

Email: zxpan@scau.edu.cn (for Z. P.)

zhongxh@scau.edu.cn (for X. Z.)

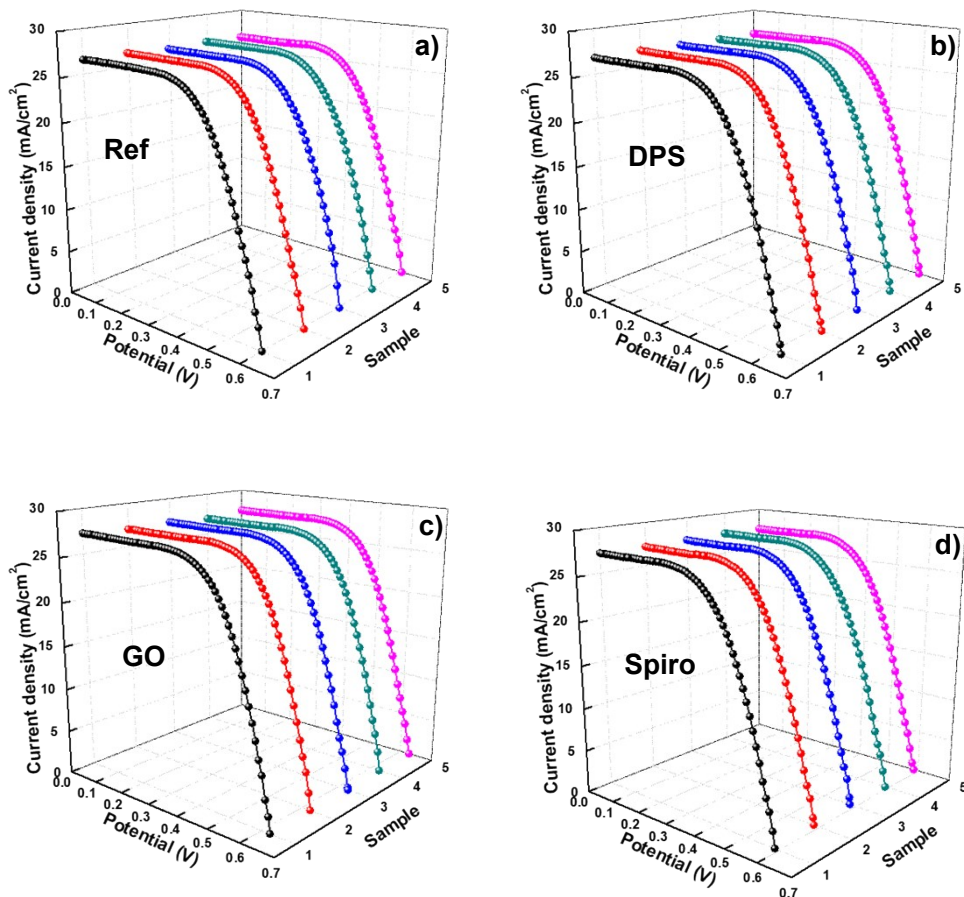


Fig. S1 *J-V* curves of ZCISE QDSCs based on: (a) reference, (b) DPS, (c) GO, and (d) Spiro-OMeTAD modification.

Table S1. Individual and average photovoltaic parameter values of ZCISE QDSCs based on reference, DPS, GO and Spiro modification under standard conditions (AM 1.5 G, 100 mW cm⁻²).

ZCISE QDSCs	V_{oc} (V)	J_{sc} (mA/cm ²)	FF (%)	PCE (%)
Ref	0.601	26.61	60.68	9.71
	0.607	26.55	60.25	9.71
	0.605	26.29	60.61	9.64
	0.605	26.52	59.78	9.59
	0.606	26.46	59.87	9.60
Average	0.605±0.002	26.49±0.12	60.24±0.41	9.65±0.06
DPS	0.623	26.78	61.91	10.33
	0.624	26.89	60.79	10.20
	0.622	26.79	61.75	10.29
	0.623	26.85	61.70	10.33
	0.622	26.92	61.37	10.28
Average	0.623±0.001	26.85±0.06	61.50±0.44	10.29±0.05
GO	0.626	27.27	63.48	10.84
	0.625	27.00	64.17	10.83
	0.631	27.13	63.03	10.79
	0.627	26.91	64.01	10.80
	0.628	27.37	62.66	10.77
Average	0.627±0.002	27.14±0.19	63.47±0.64	10.81±0.03
Spiro-OMeTAD	0.587	27.23	59.56	9.52
	0.583	27.19	59.17	9.38
	0.582	27.28	59.20	9.40
	0.589	27.46	57.81	9.35
	0.586	27.43	58.29	9.37
Average	0.585±0.002	27.32±0.12	58.80±0.73	9.40±0.07

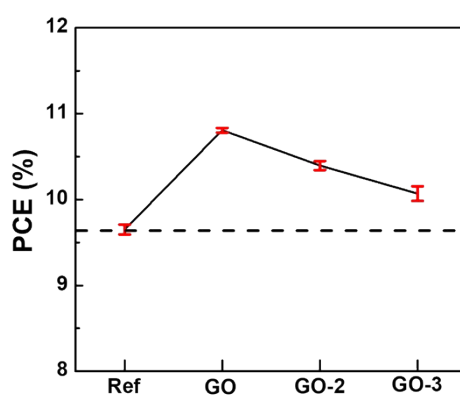


Fig. S2 PCE parameters of ZCISE-based QDSCs based on different cycles of GO modification strategy.

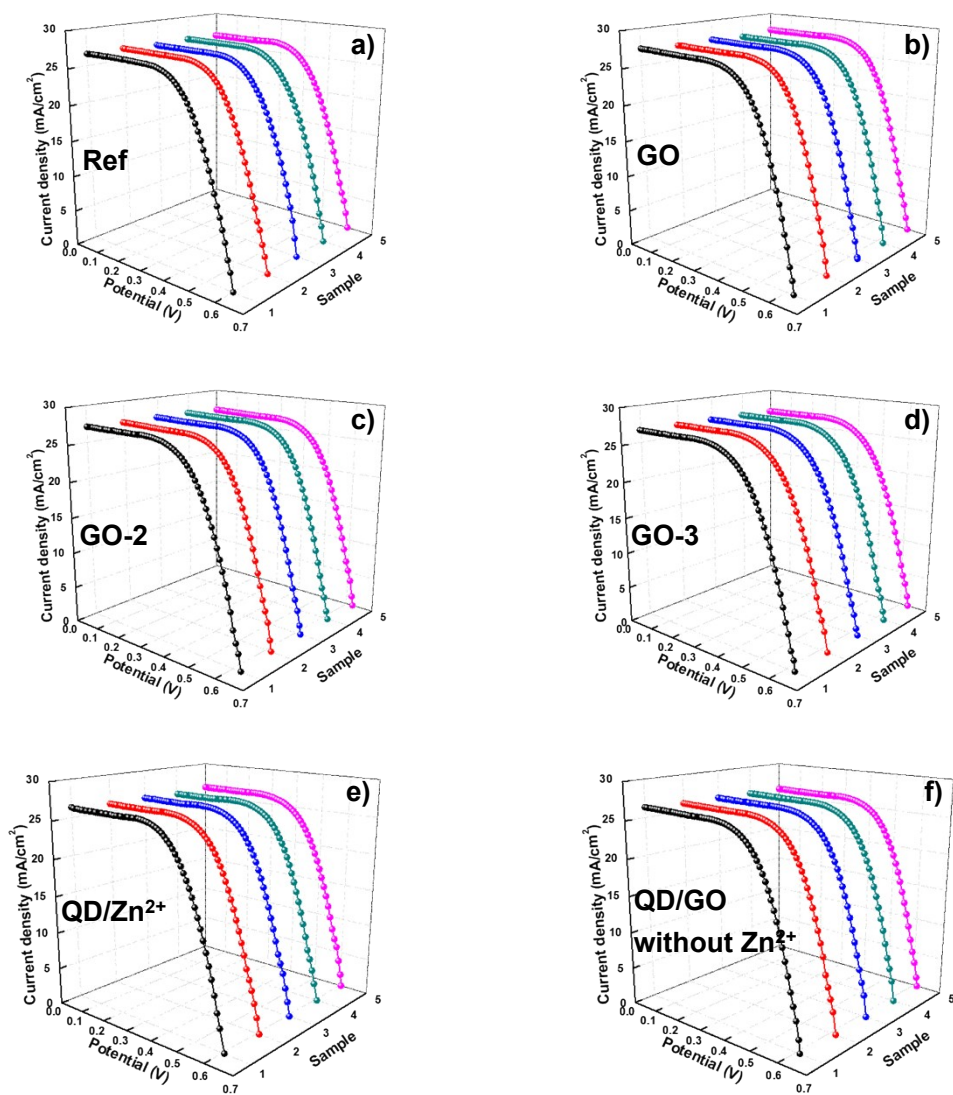


Fig. S3 *J-V* curves of ZCISE QDSCs based on (a) reference, GO modification for (b) 1 cycle (c) 2 cycles (d) 3 cycles, (e) Zn²⁺ treatment without GO modification and (f) GO modification without Zn²⁺ treatment.

Table S2. Individual and average photovoltaic parameters of ZCISE QDSCs based on different strategy of GO modification and Zn²⁺ treatment under standard conditions (AM 1.5 G, 100 mW cm⁻²).

ZCISE QDSCs	V_{oc} (V)	J_{sc} (mA/cm ²)	FF (%)	PCE (%)
Ref	0.601	26.61	60.68	9.71
	0.607	26.55	60.25	9.71
	0.605	26.29	60.61	9.64
	0.605	26.52	59.78	9.59
	0.606	26.46	59.87	9.60
Average	0.605±0.002	26.49±0.12	60.24±0.41	9.65±0.06
GO	0.626	27.27	63.48	10.84
	0.625	27.00	64.17	10.83
	0.631	27.13	63.03	10.79
	0.627	26.91	64.01	10.80
	0.628	27.37	62.66	10.77
Average	0.627±0.002	27.14±0.19	63.47±0.64	10.81±0.03
GO-2	0.629	27.12	61.34	10.47
	0.620	26.95	61.76	10.32
	0.619	27.00	62.22	10.40
	0.621	26.97	62.10	10.40
	0.625	26.82	62.46	10.39
Average	0.623±0.004	26.97±0.11	61.98±0.44	10.40±0.05
GO-3	0.629	26.61	60.58	10.14
	0.629	26.62	59.36	9.94
	0.630	26.63	59.78	10.03
	0.631	26.64	60.08	10.10
	0.630	26.61	60.49	10.14
Average	0.630±0.001	26.62±0.01	60.06±0.51	10.07±0.09
QD/Zn ²⁺	0.607	26.36	61.35	9.81
	0.610	26.03	60.52	9.64
	0.609	26.12	61.35	9.76
	0.608	26.01	61.91	9.79
	0.605	26.34	60.93	9.71
Average	0.608±0.002	26.17±0.17	61.21±0.52	9.74±0.07
QD/GO without Zn ²⁺	0.614	26.33	63.70	10.30
	0.621	26.07	63.05	10.21
	0.620	26.11	63.05	10.21
	0.620	26.05	63.11	10.20
	0.614	26.05	63.56	10.17
Average	0.618±0.003	26.12±0.12	63.29±0.31	10.22±0.05

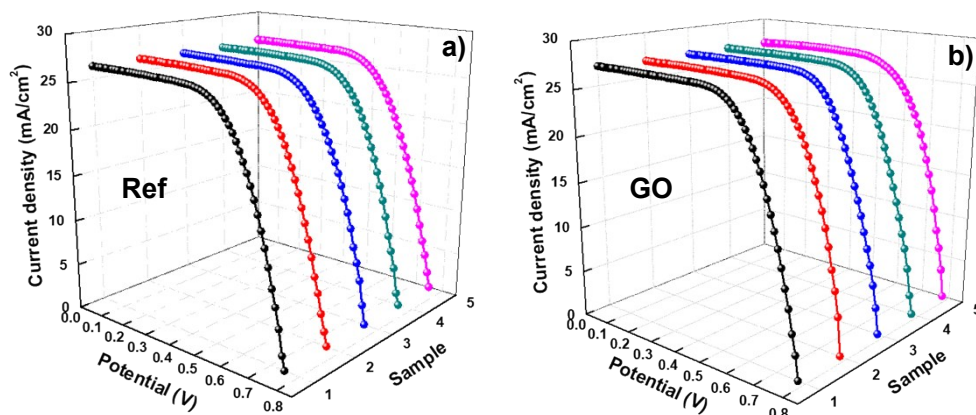


Fig. S4 J - V curves of (a) reference and (b) GO modification QDSCs based on N-MC/Ti CE.

Table S3. Individual and average photovoltaic parameter values of reference and GO modification QDSCs based on N-MC/Ti CE under standard conditions (AM 1.5 G, 100 mW cm⁻²).

N-MC/Ti CE	V_{oc} (V)	J_{sc} (mA/cm ²)	FF (%)	PCE (%)
Ref	0.749	26.33	64.14	12.65
	0.747	26.36	62.95	12.39
	0.755	26.24	63.10	12.50
	0.748	26.23	64.16	12.59
	0.751	26.49	62.50	12.40
Average	0.750±0.002	26.33±0.08	63.37±0.62	12.50±0.08
GO	0.775	27.06	66.10	13.86
	0.768	26.91	66.87	13.82
	0.775	26.96	66.00	13.79
	0.777	26.97	66.47	13.93
	0.767	27.01	66.61	13.80
Average	0.772±0.004	26.98±0.04	66.41±0.29	13.84±0.04