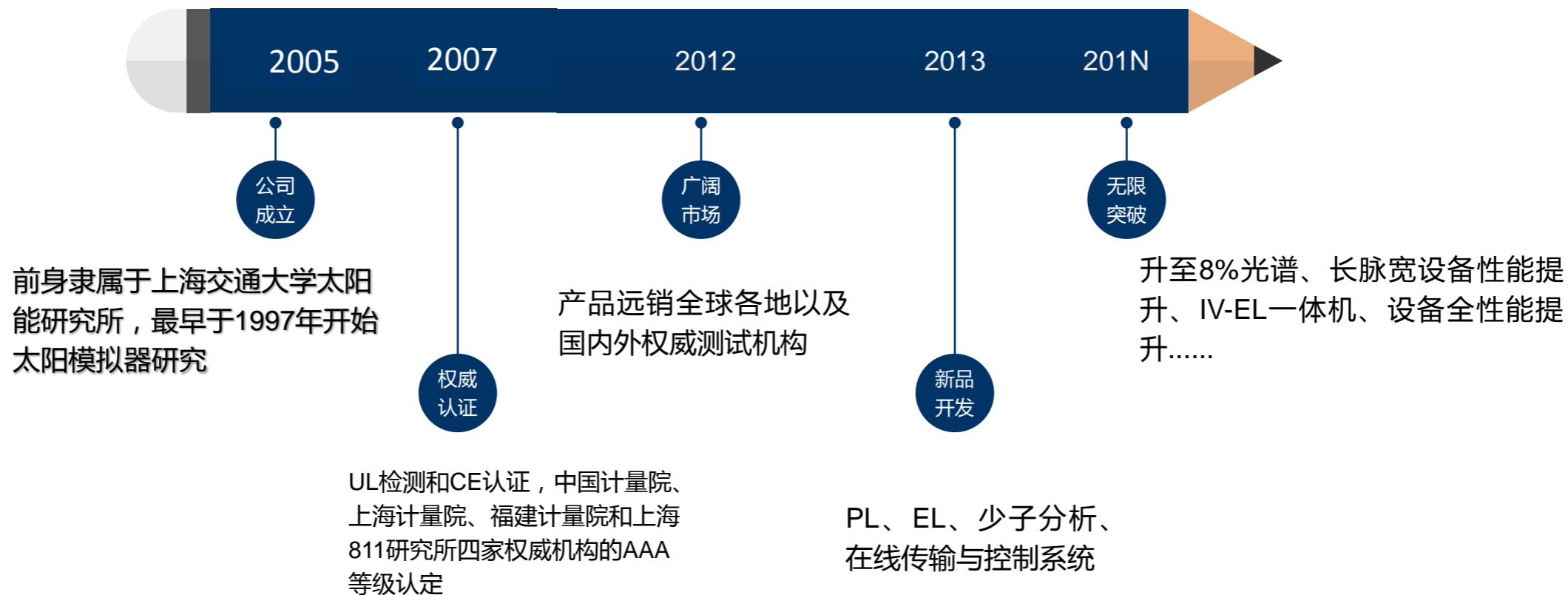


# PERC等高效电池产线测试技术发展提升

上海赫爽太阳能科技有限公司

报告人：陈玉龙



# 主要内容

- 01 高效电池对脉宽需求
- 02 脉宽与正反扫描趋势
- 03 功率不重复度再提升
- 04 产品不一致性测试
- 05 产品光谱失配对功率影响



# 01 高效电池对设备脉宽需求

## 测试设备：赫爽太阳能HSC1



	HSC1-1LA02	HSC1-1LA03
适用范围	普通晶硅电池、高效电池、薄膜电池	普通晶硅电池、高效电池、薄膜电池
测试面积	200mm*200mm 450mm*300mm	200mm*200mm 450mm*300mm
光源方向	上光源	上光源
光谱等级	A	A+ (±20%)
光强不均匀度	≤2%	≤2%
光强不稳定度STI	A	A
光强不稳定度LTI	≤2%	≤1%
脉冲宽度	100ms	100/150ms
光强范围	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>
灯管寿命	100,000次	100,000次
电压量测范围	0-1/10V	0-1/10V
电流量测范围	0-10mA/100mA/1A/10A	0-10mA/100mA/1A/10A
逆电流测试范围	-	0~(-100mA)
量测功率的不重复度	≤±0.5% (测试条件不变时)	≤±0.5% (测试条件不变时)

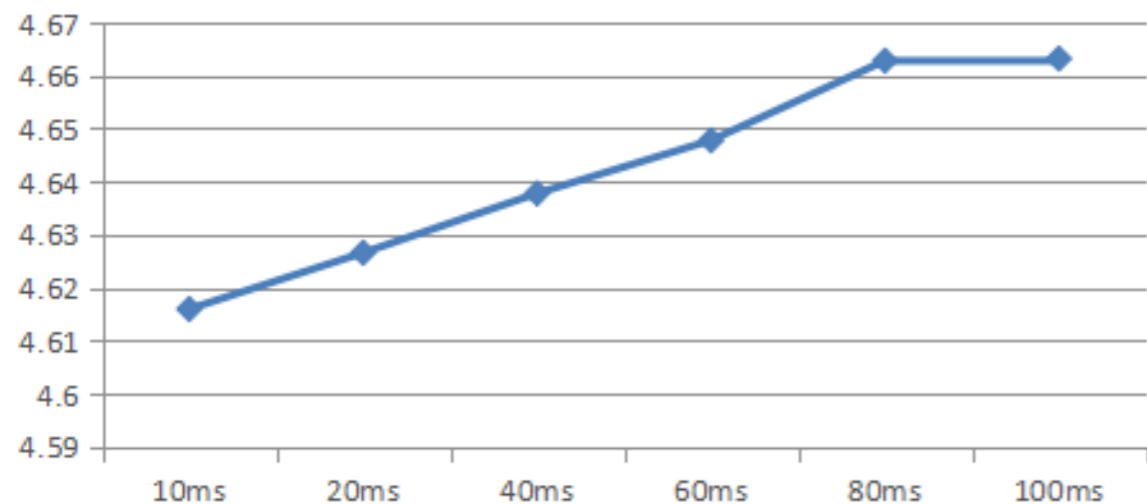
## 高效电池片测试数据

正面	脉宽	测试光强 ( $\text{mw}/\text{cm}^2$ )	测试温度 (C)	校正到光强 ( $\text{mw}/\text{cm}^2$ )	校正到温度 (C)	开路电压 (V)	短路电流 (A)	串联电阻 ( $\Omega$ )	并联电阻 ( $\Omega$ )	最大功率 (W)	功率点电压 (V)	功率点电流 (A)	填充因子 (%)	效率 (%)	定点电压 下电流
	10ms	100	24.546	100	24.546	0.63	9.6872	0.007773	3.6474	4.616	0.51262	9.0046	75.632	18.97	9.2
	20ms	100	24.602	100	24.602	0.6299	9.7098	0.007767	11.203	4.6266	0.51318	9.0158	75.642	19.012	9.1932
	40ms	100	24.62	100	24.62	0.62878	9.7092	0.007416	8.47	4.6378	0.51452	9.0138	75.962	19.056	9.2084
	60ms	100	24.632	100	24.632	0.63008	9.7098	0.007526	13.7	4.6478	0.51564	9.0138	75.968	19.1	9.2218
	80ms	100	24.62	100	24.62	0.62988	9.7042	0.007309	22.3104	4.6628	0.51674	9.0236	76.286	19.16	9.2426
	100ms	100	24.64	100	24.64	0.62408	9.7052	0.00714	27.998	4.6632	0.5161	9.0368	76.996	19.164	9.2468

反面	脉宽	测试光强 ( $\text{mw}/\text{cm}^2$ )	测试温度 (C)	校正到光强 ( $\text{mw}/\text{cm}^2$ )	校正到温度 (C)	开路电压 (V)	短路电流 (A)	串联电阻 ( $\Omega$ )	并联电阻 ( $\Omega$ )	最大功率 (W)	功率点电压 (V)	功率点电流 (A)	填充因子 (%)	效率 (%)	定点电压 下电流
	10ms	100	24.676	100	24.676	0.6448	8.5114	0.008227	21.017	4.3282	0.53606	8.0746	78.866	17.788	8.359
	20ms	100	24.732	100	24.732	0.6462	8.5148	0.007441	15.6038	4.3756	0.5405	8.0954	79.518	17.98	8.3978
	40ms	100	24.62	100	24.62	0.64282	8.526	0.007593	17.8828	4.3948	0.54214	8.1072	80.194	18.06	8.4124
	60ms	100	24.684	100	24.684	0.64266	8.5236	0.007501	13.6344	4.3978	0.54226	8.11	80.28	18.072	8.4164
	80ms	100	24.664	100	24.664	0.64206	8.5236	0.007351	4.906	4.4008	0.54222	8.116	80.412	18.084	8.4208
	100ms	100	24.68	100	24.68	0.63912	8.5298	0.007767	8.926	4.401	0.54154	8.1272	80.728	18.082	8.4252

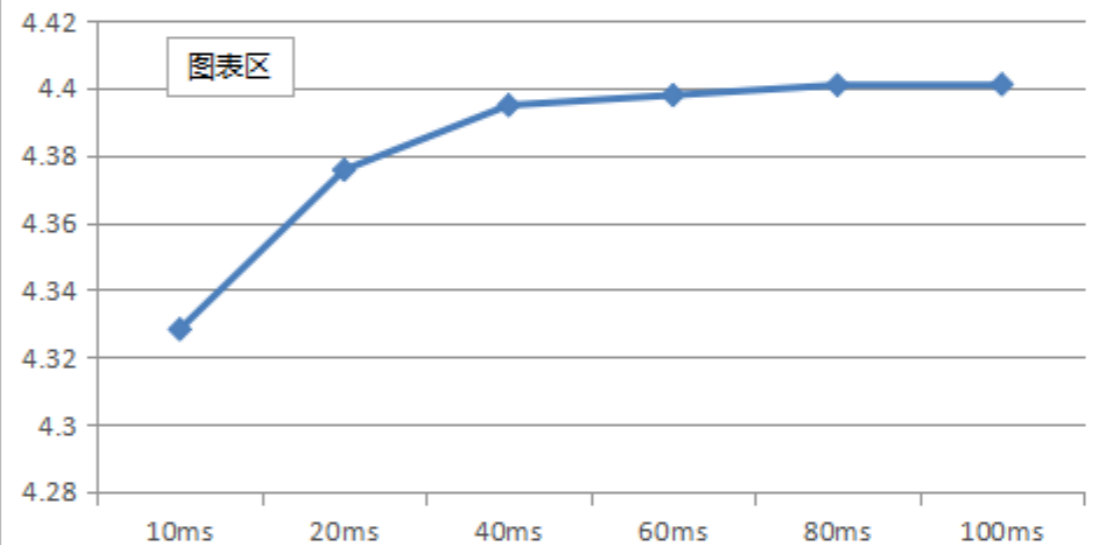
正面

### 不同脉宽下正面Pm变化趋势



反面

### 不同脉宽下反面Pm变化趋势





# 02 长脉宽设备正反扫描功率趋势

## 测试设备：赫爽太阳能HSM2



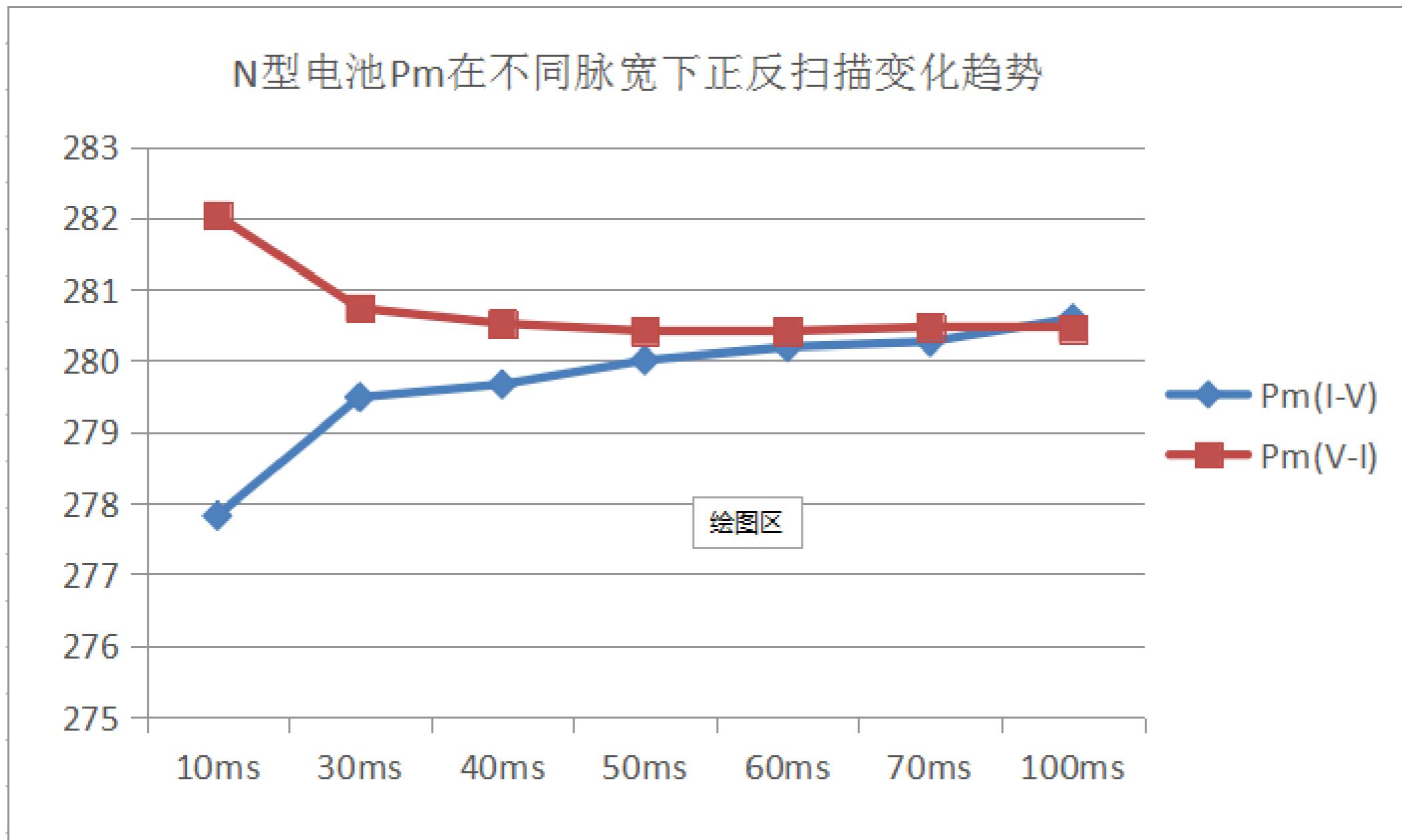
	HSM2-2LA02	HSM2-2LA03	HSM2-2LA04
适用范围	普通晶硅电池组件、高效电池组件、薄膜电池组件		
测试面积	1100mm*2000mm	1100mm*2000mm 1300mm*2000mm	1100mm*2000mm 1300mm*2000mm
光源方向	下光源	下光源	下光源
光谱等级 (IEC 60904-9)	A	A+ (±12.5%)	A+ (±12.5%)
全光谱	-	-	300nm-1200nm
光强不均匀度	≤2%	≤1%	≤1%
光强不稳定性STI	A	A	A
光强不稳定性LTI	≤2%	≤1%	≤1%
脉冲宽度	100ms	100ms	100/150ms
光强范围	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>
灯管寿命	100,000次	100,000次	100,000次
电压量测范围	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制
电流量测范围	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A
量测功率的 不重复度	≤±0.3% (测试条件不变 时)	<b>≤±0.2%</b> (测试条件不变 时)	<b>≤±0.2%</b> (测试条件不变 时)

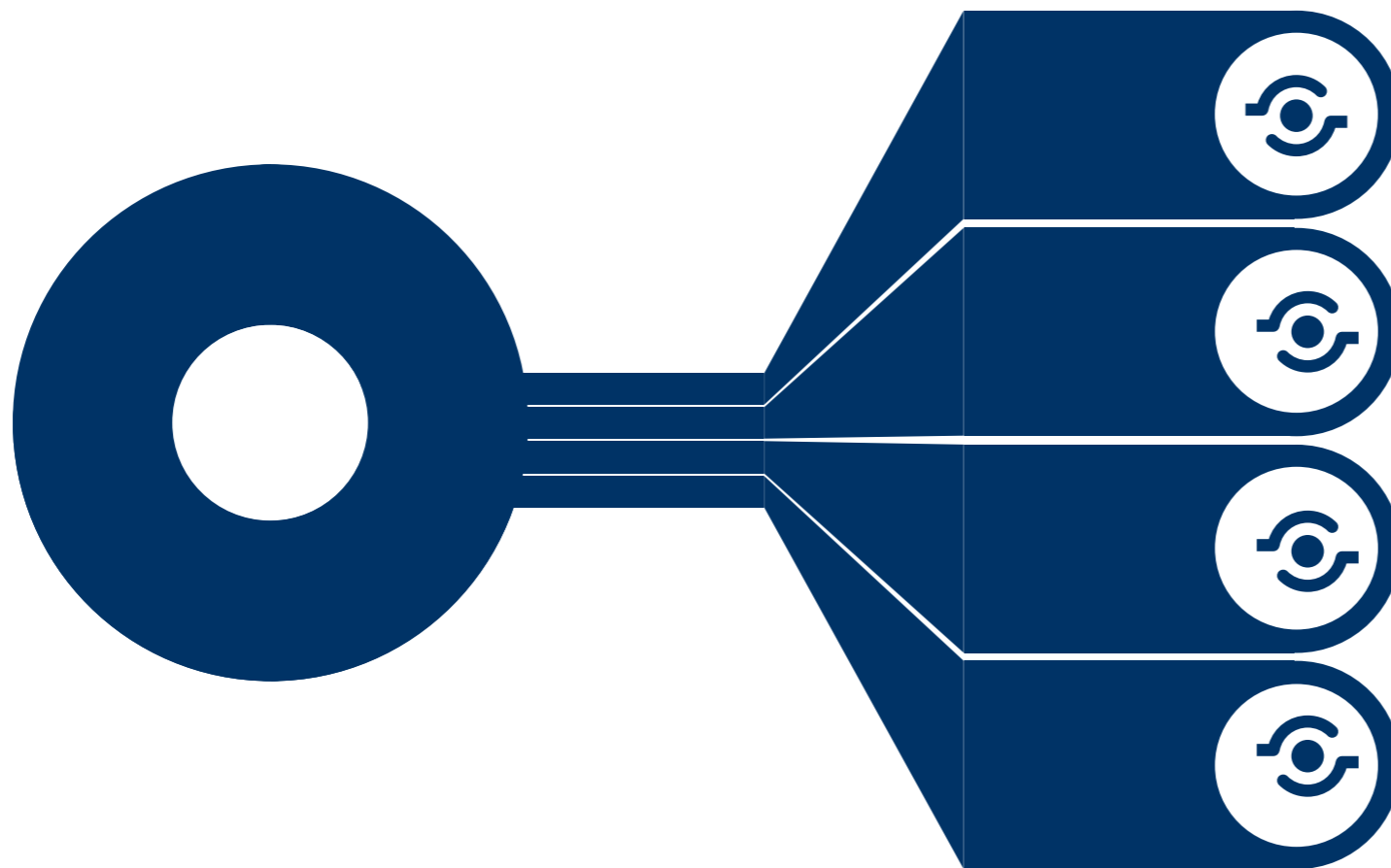
## 高效电池组件测试数据

脉宽	Temperatu	Voc	Isc	Pm(I-V)				$\eta_{Cell}$	$\eta_{Module}$
				Pmax	Vm	Im	FF		
10ms	25.4	38.32763	9.3362	277.823	31.30981	8.873353	77.6401	19.02688	17.11154
30ms	25.4	38.34087	9.33771	279.4836	31.4477	8.887253	78.06457	19.14062	17.213823
40ms	25.3	38.34552	9.331471	279.6662	31.45075	8.892198	78.15833	19.15312	17.225071
50ms	25.5	38.32074	9.3372	280.005	31.47293	8.896695	78.25559	19.17633	17.245937
60ms	25.4	38.33921	9.342447	280.1888	31.47136	8.902974	78.22523	19.18891	17.257252
70ms	25.5	38.31518	9.342052	280.2623	31.47356	8.904691	78.29815	19.19395	17.261782
100ms	25.5	37.07355	9.335166	280.5873	31.49521	8.908891	81.07405	19.21621	17.281803

脉宽	Temperatu	Voc	Isc	Pm(V-I)				$\eta_{Cell}$	$\eta_{Module}$
				Pmax	Vm	Im	FF		
10ms	25.5	38.5989	9.362313	282.0354	31.74208	8.885221	78.04507	19.31537	17.370989
30ms	25.6	38.36309	9.362576	280.7331	31.5789	8.889894	78.16003	19.22619	17.290781
40ms	25.5	38.40463	9.360889	280.5175	31.55794	8.888969	78.02959	19.21142	17.277502
50ms	25.4	38.37852	9.358429	280.4117	31.53366	8.892456	78.07373	19.20418	17.270985
60ms	25.4	38.38019	9.356899	280.4107	31.54087	8.890392	78.08283	19.20411	17.270926
70ms	25.4	38.38606	9.357763	280.4687	31.52544	8.896585	78.07983	19.20808	17.274496
100ms	25.5	38.38862	9.272855	280.4457	31.51377	8.89915	78.78307	19.20651	17.273081

N型电池Pm在不同脉宽下正反扫描变化趋势





功率随着脉宽逐步提升到稳定状态

FF逐步增大至稳定状态

脉宽在80ms以后趋于稳定

更长脉宽更适用于高效电池

# 03 功率不重复度再提升

## 测试设备：赫爽太阳能HSM2



	HSM2-2LA02	HSM2-2LA03	HSM2-2LA04
适用范围	普通晶硅电池组件、高效电池组件、薄膜电池组件		
测试面积	1100mm*2000mm	1100mm*2000mm 1300mm*2000mm	1100mm*2000mm 1300mm*2000mm
光源方向	下光源	下光源	下光源
光谱等级 (IEC 60904-9)	A	A+ (±12.5%)	A+ (±12.5%)
全光谱	-	-	300nm-1200nm
光强不均匀度	≤2%	≤1%	≤1%
光强不稳定性STI	A	A	A
光强不稳定性LTI	≤2%	≤1%	≤1%
脉冲宽度	100ms	100ms	100/150ms
光强范围	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>
灯管寿命	100,000次	100,000次	100,000次
电压量测范围	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制
电流量测范围	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A
量测功率的不重复度	≤±0.3% (测试条件不变时)	<b>≤±0.2%</b> (测试条件不变时)	<b>≤±0.2%</b> (测试条件不变时)

1	T	Voc	Isc	Pmax	Vm	Im	FF	$\eta_{Cell}$	$\eta_{Module}$	Ress	Ressh	envtemp
2	25	36.73135	8.485665	234.288834	29.455063	7.954111	75.167274	390.481384	23428.88477	0.461813	82.33546	25.4
3	25	36.723076	8.488773	234.249146	29.450909	7.953885	75.143944	390.415222	23424.91406	0.452395	72.6651	25.4
4	25	36.72538	8.486955	234.268509	29.456715	7.952975	75.161552	390.44751	23426.85156	0.453882	77.74983	25.4
5	25	36.710194	8.491018	234.161148	29.4461	7.952196	75.122215	390.268585	23416.11523	0.455198	69.30933	25.3
6	25	36.711594	8.489424	234.123871	29.438049	7.953104	75.121498	390.206451	23412.38672	0.450584	69.43911	25.3
7	25	36.710499	8.486855	234.14711	29.437866	7.953943	75.153938	390.245178	23414.71094	0.445597	75.55997	25.3
8	25	36.717407	8.489531	234.294693	29.465508	7.95149	75.16346	390.49115	23429.46875	0.448776	69.19776	25.4
9	25	36.716518	8.488694	234.255585	29.452148	7.953769	75.160141	390.425964	23425.55859	0.452982	71.17993	25.4
10	25	36.725754	8.487615	234.192276	29.457989	7.950043	75.130486	390.320465	23419.22852	0.462007	73.64585	25.4
11	25	36.716412	8.488327	234.194656	29.449589	7.952391	75.144058	390.324432	23419.46484	0.455637	71.65742	25.4
12	25	36.721466	8.489706	234.197052	29.455734	7.950814	75.122276	390.32843	23419.70508	0.451482	68.00063	25.4
13	25	36.719151	8.486289	234.214142	29.435877	7.956758	75.16275	390.356903	23421.41406	0.453442	74.23039	25.4
14	25	36.714046	8.490889	234.172424	29.443838	7.95319	75.119095	390.287384	23417.24219	0.450839	68.13242	25.4
15	25	36.714897	8.488207	234.230072	29.455843	7.951905	75.159584	390.383453	23423.00781	0.455147	69.95248	25.4
16	25	36.711349	8.486913	234.172363	29.444742	7.952943	75.15979	390.287292	23417.23633	0.448093	71.01077	25.4
17	25	36.721985	8.487938	234.187088	29.456558	7.950253	75.133667	390.311829	23418.70898	0.46042	69.91845	25.4
18	25	36.708118	8.492831	234.22052	29.449888	7.953188	75.129471	390.367523	23422.05078	0.457919	62.54102	25.4
19	25	36.714657	8.48424	234.177612	29.452089	7.951137	75.178383	390.296021	23417.76172	0.453287	78.65492	25.4
20	25	36.715046	8.489895	234.217331	29.450352	7.952955	75.140244	390.362213	23421.73242	0.453605	66.33492	25.4
21	25	36.712746	8.484115	234.139923	29.445597	7.951611	75.171295	390.233185	23413.99219	0.447661	79.10488	25.4
22	25	36.710014	8.483396	234.106552	29.445698	7.95045	75.172554	390.177582	23410.65625	0.447697	80.23457	25.4
23	25	36.708778	8.4865	234.183228	29.456671	7.950091	75.172195	390.305359	23418.32227	0.450982	73.3925	25.4
24	25	36.702744	8.484519	234.195435	29.445366	7.953558	75.206032	390.325714	23419.54297	0.447085	76.94348	25.4
25	25	36.70702	8.4844	234.163849	29.452753	7.950491	75.188179	390.273071	23416.38477	0.446898	76.41415	25.4
26	25	36.720345	8.482371	234.209717	29.455379	7.951339	75.193596	390.349518	23420.9707	0.458084	79.72409	25.5
27	25	36.718201	8.481018	234.243103	29.454039	7.952835	75.220711	390.405182	23424.31055	0.446268	81.73754	25.5
28	25	36.719955	8.485814	234.2323	29.471148	7.947851	75.171143	390.387146	23423.23047	0.449457	70.73713	25.5
29	25	36.718483	8.484094	234.23494	29.468405	7.948681	75.190247	390.391571	23423.49414	0.452871	75.79685	25.5
30	25	36.71936	8.481991	234.234161	29.471865	7.947721	75.206833	390.390289	23423.41602	0.449798	80.27403	25.5
31	25	36.716789	8.485586	234.292007	29.458889	7.953185	75.198799	390.486664	23429.19922	0.452104	70.99415	25.5
32	25	36.716133	8.48459	234.181076	29.459324	7.949302	75.173378	390.301788	23418.10742	0.442902	72.67024	25.5
33	25	36.720093	8.485611	234.218307	29.472551	7.946998	75.168159	390.363831	23421.83008	0.452744	72.14842	25.5
34	25	36.723133	8.48428	234.262146	29.46327	7.950989	75.187813	390.43692	23426.21484	0.45443	74.78375	25.5
35	25	36.716877	8.480514	234.160263	29.454233	7.94997	75.201302	390.26709	23416.02539	0.457583	82.52123	25.5
36	25	36.715981	8.48383	234.188126	29.451111	7.951758	75.182671	390.313538	23418.8125	0.443895	75.64457	25.5
37	25	36.711643	8.484426	234.235062	29.461178	7.950634	75.20134	390.391754	23423.50586	0.444305	74.45771	25.5
38	25	36.708817	8.481147	234.195786	29.460533	7.949475	75.223602	390.326294	23419.57813	0.443015	81.48532	25.5
39	25	36.718666	8.481459	234.194244	29.456884	7.950408	75.200157	390.32373	23419.42383	0.441436	80.00442	25.5
40	25	36.717392	8.483449	234.221954	29.464828	7.949205	75.194031	390.369934	23422.19531	0.450178	74.42862	25.5

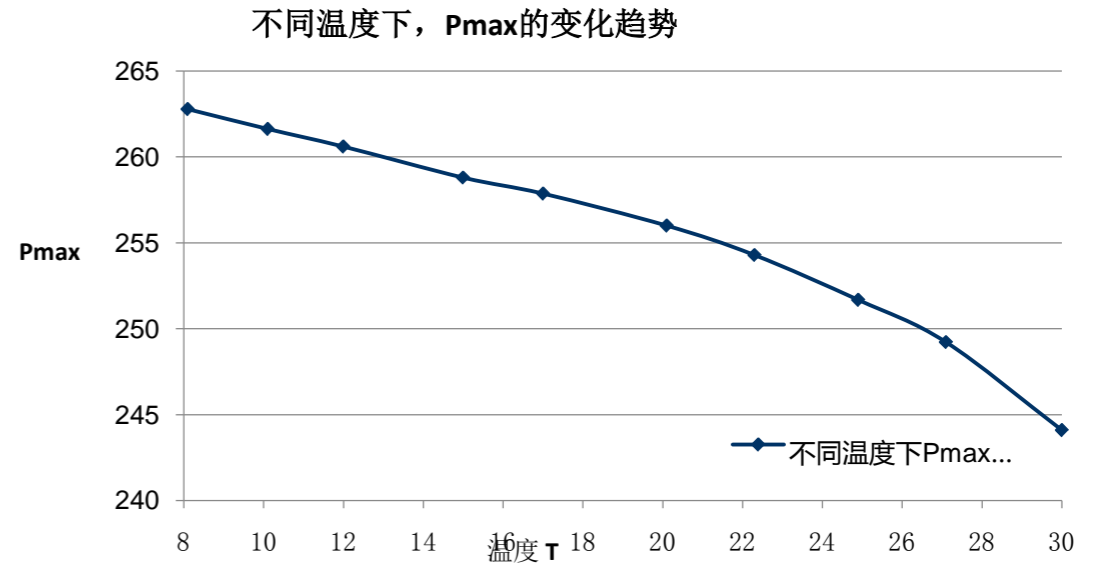
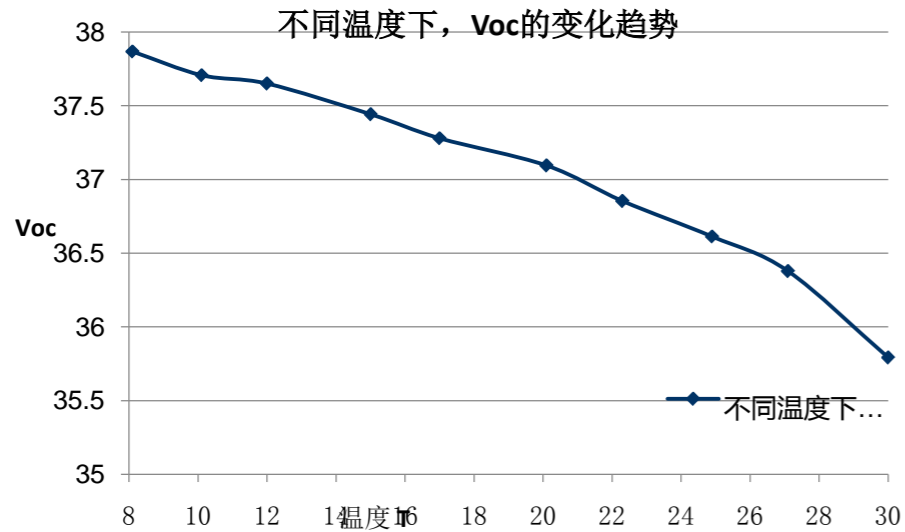


41	25	36.720043	8.480519	234.199921	29.463169	7.948905	75.207497	390.333221	23419.99219	0.449606	79.91453	25.5
42	25	36.709919	8.483233	234.124817	29.453655	7.948922	75.180054	390.208038	23412.48242	0.440387	74.55682	25.5
43	25	36.71571	8.483671	234.211792	29.460669	7.949982	75.192238	390.352997	23421.17969	0.443142	72.01387	25.5
44	25	36.714596	8.478652	234.145004	29.456894	7.948733	75.217567	390.241669	23414.5	0.447017	82.10482	25.5
45	25	36.718861	8.479041	234.158905	29.458174	7.94886	75.209854	390.264832	23415.89063	0.441342	84.32003	25.5
46	25	36.715069	8.481728	234.143951	29.457592	7.948509	75.188995	390.239899	23414.39453	0.442006	73.93958	25.5
47	25	36.721107	8.481883	234.189682	29.469875	7.946748	75.189934	390.316132	23418.96875	0.45345	76.4127	25.5
48	25	36.710629	8.480411	234.172455	29.470966	7.94587	75.218925	390.287445	23417.24609	0.447942	79.20324	25.5
49	25	36.711971	8.477373	234.180267	29.463379	7.948181	75.245628	390.300446	23418.02734	0.444161	85.10677	25.5
50	25	36.707092	8.481513	234.114075	29.453924	7.948485	75.197639	390.190125	23411.4082	0.438428	75.17194	25.5
51	25	36.710701	8.481999	234.217636	29.462942	7.949567	75.2192	390.362732	23421.76367	0.441309	72.79432	25.5
52	25	36.710999	8.48238	234.118286	29.460787	7.946776	75.183304	390.197144	23411.82813	0.447318	71.73402	25.5
53	25	36.710339	8.47699	234.149796	29.459951	7.948071	75.242592	390.249664	23414.97852	0.446261	83.76207	25.5
54	25	36.714722	8.484311	234.115524	29.456675	7.947792	75.157684	390.192535	23411.55273	0.445333	67.64565	25.5
55	25	36.706577	8.479403	234.145691	29.458748	7.948257	75.22757	390.242828	23414.57031	0.446954	78.18658	25.5
56	25	36.715363	8.480772	234.072342	29.447012	7.948934	75.173866	390.120575	23407.23438	0.45671	74.01863	25.5
57	25	36.710548	8.48245	234.118225	29.45623	7.948004	75.183594	390.197052	23411.82227	0.45049	71.91402	25.5
58	25	36.715363	8.480329	234.152176	29.465557	7.94664	75.203438	390.253601	23415.2168	0.447938	74.61219	25.5
59	25	36.711681	8.481124	234.223297	29.470882	7.947618	75.226776	390.372162	23422.33008	0.446439	72.10246	25.5
60	25	36.715816	8.481837	234.09201	29.459909	7.946121	75.169815	390.153351	23409.20117	0.448362	70.7786	25.5
61	25	36.702164	8.481418	234.161469	29.467487	7.946435	75.223808	390.269104	23416.14648	0.450422	72.12206	25.5
62	25	36.712234	8.482877	234.110443	29.458052	7.947248	75.173859	390.184082	23411.04492	0.450448	68.91093	25.5
63	25	36.709194	8.48067	234.056229	29.453783	7.946559	75.182228	390.093719	23405.62305	0.438996	71.97208	25.5
64	25	36.712822	8.480106	234.100952	29.462797	7.945645	75.194153	390.168243	23410.0957	0.44804	73.1308	25.5
65	25	36.710125	8.48072	234.139343	29.463779	7.946684	75.206573	390.232239	23413.93359	0.452015	69.86839	25.5
66	25	36.713943	8.478271	234.06366	29.455809	7.946265	75.196167	390.10611	23406.36523	0.444927	76.26372	25.5
67	25	36.708591	8.476553	234.060654	29.451603	7.947298	75.221397	390.101074	23406.06445	0.446465	81.40166	25.5
68	25	36.709877	8.481261	234.104843	29.464457	7.945331	75.191208	390.174744	23410.48438	0.449287	69.13473	25.5
69	25	36.707233	8.482417	234.047485	29.458418	7.945012	75.167953	390.079163	23404.75	0.445746	68.1806	25.5
70	25	36.712326	8.477316	234.074524	29.463829	7.94447	75.211433	390.124207	23407.45313	0.446837	77.74011	25.5
71	25	36.705673	8.482584	234.099701	29.456171	7.947391	75.186432	390.166168	23409.96875	0.445673	67.55827	25.5
72	25	36.704128	8.479887	234.082581	29.459505	7.94591	75.208015	390.137634	23408.25781	0.443925	73.1112	25.5
73	25	36.709255	8.478233	234.022018	29.459082	7.943969	75.192711	390.036713	23402.20117	0.44822	76.3346	25.5
74	25	36.709068	8.479803	234.056686	29.454914	7.94627	75.190323	390.094482	23405.66797	0.445709	71.88293	25.5
75	25	36.710609	8.479091	234.012833	29.460255	7.94334	75.179398	390.021393	23401.2832	0.441368	72.45455	25.5
76	25	36.710278	8.479621	234.033203	29.457207	7.944854	75.181923	390.055359	23403.32031	0.4461	71.08184	25.5
77	25	36.710018	8.477546	234.027817	29.452179	7.946027	75.19912	390.046356	23402.78125	0.456163	76.28128	25.5
78	25	36.709114	8.478929	233.996735	29.458496	7.943268	75.178719	389.994537	23399.67383	0.440232	72.73512	25.5
79	25	36.706573	8.476704	233.983185	29.455431	7.943635	75.199303	389.971985	23398.31836	0.449699	76.83828	25.5

80	25	36.703659	8.47688	233.991241	29.453991	7.944297	75.206299	389.985413	23399.125	0.451978	76.97062	25.5
81	25	36.706638	8.477142	234.100021	29.459131	7.946603	75.232826	390.166687	23410.00195	0.448926	77.07159	25.5
82	25	36.703197	8.482703	234.081772	29.461094	7.945454	75.184692	390.136292	23408.17773	0.442764	66.40936	25.5
83	25	36.709187	8.481909	234.032913	29.45644	7.945051	75.163773	390.054871	23403.29102	0.456648	65.64999	25.5
84	25	36.708359	8.479059	234.032562	29.461348	7.943716	75.19062	390.05426	23403.25586	0.459981	73.68639	25.5
85	25	36.704765	8.480123	234.0215	29.453516	7.945452	75.184998	390.035828	23402.15039	0.456256	69.98447	25.5
86	25	36.69286	8.47711	233.893295	29.438238	7.94522	75.194901	389.822174	23389.33008	0.447952	77.85702	25.4
87	25	36.692677	8.478867	233.96315	29.450703	7.94423	75.202156	389.938599	23396.31641	0.446733	74.19466	25.4
88	25	36.70467	8.478196	234.058136	29.460281	7.944871	75.214043	390.096893	23405.81445	0.443196	72.42735	25.5
89	25	36.707111	8.479192	234.017105	29.462791	7.942802	75.187035	390.028503	23401.71094	0.444307	70.75417	25.5
90	25	36.687893	8.48125	233.899292	29.442251	7.944341	75.170303	389.832153	23389.92969	0.439414	66.53409	25.4
91	25	36.700645	8.477565	233.876602	29.442205	7.943583	75.169548	389.794342	23387.66016	0.448774	74.08515	25.4
92	25	36.698593	8.477401	233.922211	29.441744	7.945257	75.189865	389.870331	23392.2207	0.441868	75.03394	25.4
93	25	36.704727	8.479348	234.05011	29.462868	7.943901	75.201126	390.083496	23405.00977	0.451299	69.85624	25.5
94	25	36.710045	8.479402	233.957047	29.450598	7.944051	75.159866	389.928406	23395.70508	0.451483	67.79554	25.5
95	25	36.70731	8.477263	233.915924	29.453026	7.941999	75.171211	389.859863	23391.5918	0.446731	73.74302	25.5
96	25	36.714798	8.475989	234.030121	29.452772	7.945945	75.203873	390.050201	23403.01172	0.452984	74.438	25.5
97	25	36.70903	8.480436	233.959366	29.451771	7.943813	75.153519	389.932281	23395.9375	0.44732	66.49648	25.5
98	25	36.713722	8.478018	234.032913	29.461979	7.943557	75.18898	390.05484	23403.29102	0.451857	70.30068	25.5
99	25	36.71344	8.479782	233.98349	29.452684	7.944386	75.158043	389.972473	23398.34961	0.459662	67.53558	25.5
100	25	36.708912	8.479343	233.948532	29.44972	7.943998	75.159966	389.914215	23394.85156	0.447391	68.29257	25.5
101	25	36.70969	8.478653	233.952942	29.450731	7.943875	75.165916	389.92157	23395.29297	0.461055	69.88277	25.5
102	不重复度	0.059%	0.099%	0.089%	0.062%	0.093%	0.084%					

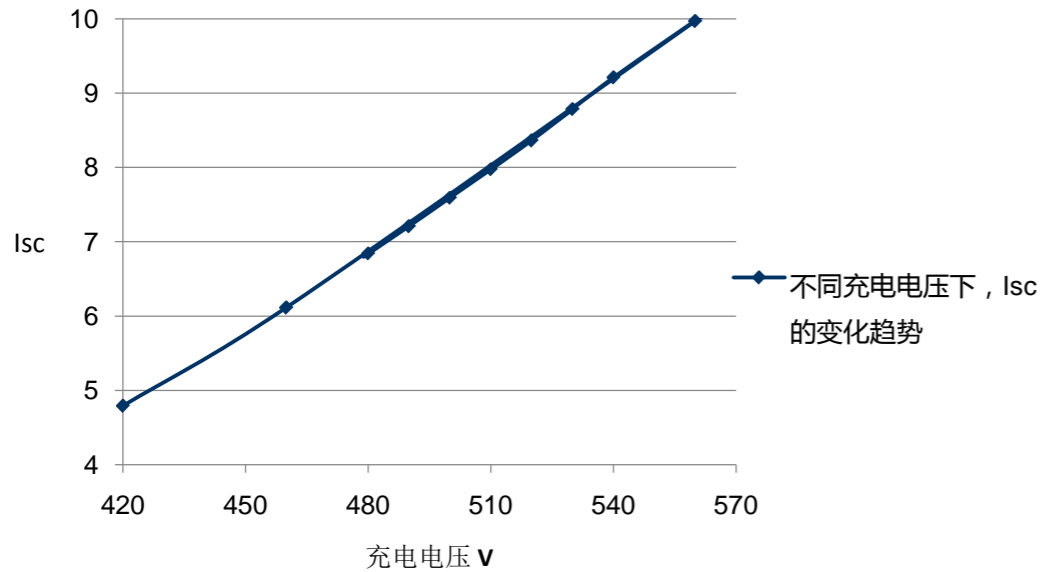
计算公式： $=(MAX(D2:D101)-MIN(D2:D101))/(MAX(D2:D101)+MIN(D2:D101))$

Temperatu	Voc	Isc	Pmax	Vm	Im	FF	TestTime	envtemp
8.1	37.86865	8.999207	262.7855	30.92437	8.497684	77.11118	11:00:29,	8.1
10.1	37.70784	9.006923	261.6364	30.77822	8.500699	77.03534	11:01:52,	10.1
12	37.65008	9.012075	260.6103	30.6491	8.503034	76.80702	11:02:08,	12
15	37.44129	9.020098	258.8086	30.44228	8.501617	76.63315	11:02:30,	15
17	37.27977	9.030559	257.8668	30.30045	8.510327	76.59626	11:04:22,	17
20.1	37.09375	9.052919	255.9992	30.04924	8.519325	76.2341	11:04:45,	20.1
22.3	36.85384	9.061809	254.3036	29.84941	8.519551	76.14736	11:06:01,	22.3
24.9	36.61311	9.071323	251.6809	29.55692	8.515128	75.77798	11:06:34,	24.9
27.1	36.37779	9.083366	249.2298	29.27229	8.514187	75.42525	11:08:46,	27.1
30	35.79153	9.099995	244.1	28.6814	8.510744	74.94565	11:11:22,	30

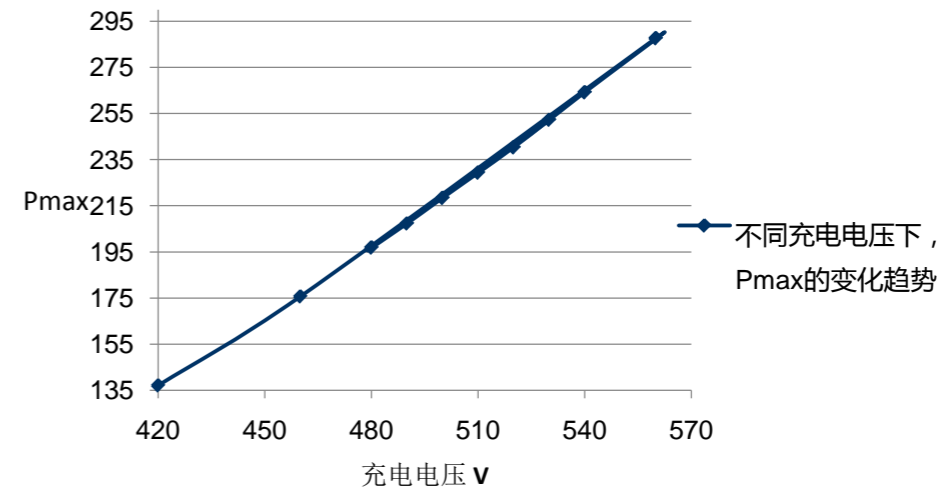


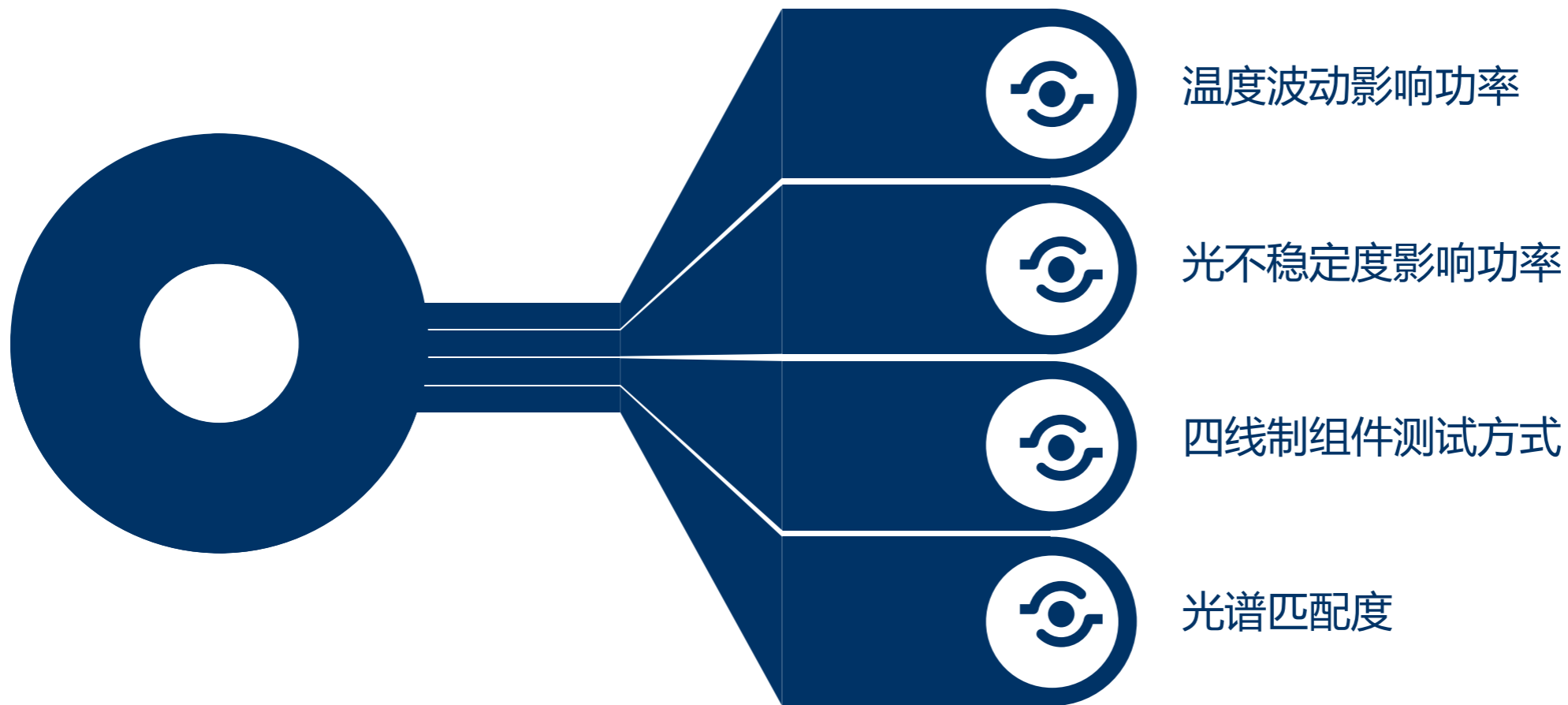
充电电压	Temperatu	Voc	Isc	Pmax	Vm	Im	FF	Test Time	envtemp
510	25	37.67716	7.978564	229.3526	30.69492	7.472005	76.29582	12:39:43,	18.3
530	25	37.80728	8.789042	252.36	30.68008	8.225535	75.94576	12:40:05,	18.3
480	25	37.37544	6.845205	196.9218	30.73129	6.40786	76.96991	12:41:08,	18.3
490	25	37.47423	7.210282	207.3548	30.73135	6.747338	76.7413	12:41:26,	18.3
500	25	37.59343	7.595662	218.4152	30.72382	7.108986	76.49011	12:42:05,	18.3
520	25	37.72088	8.364418	240.3137	30.69451	7.829208	76.16598	12:42:20,	18.3
540	25	37.91172	9.211591	264.1899	30.66051	8.61662	75.64987	12:42:43,	18.3
560	25	38.10229	9.972162	287.6816	30.57567	9.40884	75.71321	12:43:04,	18.3
460	25	37.22176	6.115743	175.7304	30.70972	5.722304	77.19706	12:43:54,	18.3
420	25	36.80035	4.792915	137.1014	30.6559	4.472269	77.73029	12:44:42,	18.3

不同光辐照度, Isc的变化趋势



不同光辐照度, Pmax的变化趋势





# 04 产品不一致性测试

## 测试设备：赫爽太阳能HSM2



	HSM2-2LA02	HSM2-2LA03	HSM2-2LA04
适用范围	普通晶硅电池组件、高效电池组件、薄膜电池组件		
测试面积	1100mm*2000mm	1100mm*2000mm 1300mm*2000mm	1100mm*2000mm 1300mm*2000mm
光源方向	下光源	下光源	下光源
光谱等级 (IEC 60904-9)	A	A+ (±12.5%)	A+ (±12.5%)
全光谱	-	-	300nm-1200nm
光强不均匀度	≤2%	≤1%	≤1%
光强不稳定性STI	A	A	A
光强不稳定性LTI	≤2%	≤1%	≤1%
脉冲宽度	100ms	100ms	100/150ms
光强范围	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>
灯管寿命	100,000次	100,000次	100,000次
电压量测范围	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制
电流量测范围	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A
量测功率的不重复度	≤±0.3% (测试条件不变时)	<b>≤±0.2%</b> (测试条件不变时)	<b>≤±0.2%</b> (测试条件不变时)

	T	Voc	Isc	Pmax	Vm	Im	FF	TestTime	envtemp
仪器1 测试板数据	25	46.294366	9.23295	327.4514088	37.579206	8.714249	76.610854	09:35:06,	20.5
	25	46.387581	9.205137	327.627771	37.454254	8.744741	76.703674	09:35:17,	20.5
	25	46.385288	9.214878	327.563843	37.431686	8.750978	76.634811	09:35:20,	20.5
	25	46.386024	9.203684	327.639673	37.455982	8.744656	76.721138	09:35:26,	20.5
	25	46.383774	9.205595	327.551178	37.450748	8.746185	76.711639	09:35:34,	20.5
Ave				327.5668					
	T	Voc	Isc	Pmax	Vm	Im	FF	TestTime	envtemp
仪器2 测试板数据	20.4	46.319179	9.22941	327.6763343	37.618087	8.710606	76.2614005	09:48:06	20.0
	20.4	46.45015	9.257812	327.953217	37.787075	8.678979	76.263451	09:48:12	20.0
	20.4	46.443302	9.258697	327.901245	37.780731	8.67906	76.255318	09:48:21	20.0
	20.4	46.445072	9.258484	327.902435	37.782791	8.678618	76.25444	09:48:25	20.0
	20.4	46.447598	9.258328	327.938629	37.781521	8.679868	76.259987	09:48:29	20.0
Ave				327.87437	327.6763343				
不一致性				0.094%					

测试方法：标准板一块，测试板一块，分别测试两台仪器，计算出两台仪器的不一致性

计算公式： $= (E14 - E7) / E14$



# 05 产品光谱失配对功率的影响

## 测试设备：赫爽太阳能HSM2



	HSM2-2LA02	HSM2-2LA03	HSM2-2LA04
适用范围	普通晶硅电池组件、高效电池组件、薄膜电池组件		
测试面积	1100mm*2000mm	1100mm*2000mm 1300mm*2000mm	1100mm*2000mm 1300mm*2000mm
光源方向	下光源	下光源	下光源
光谱等级 (IEC 60904-9)	A	A+ (±12.5%)	A+ (±12.5%)
全光谱	-	-	300nm-1200nm
光强不均匀度	≤2%	≤1%	≤1%
光强不稳定性STI	A	A	A
光强不稳定性LTI	≤2%	≤1%	≤1%
脉冲宽度	100ms	100ms	100/150ms
光强范围	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>	200-1200 W/m <sup>2</sup>
灯管寿命	100,000次	100,000次	100,000次
电压量测范围	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制	0-1/10/50/100 /150V其他可定制
电流量测范围	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A	0-10mA/100mA/ 1A/10A
量测功率的不重复度	≤±0.3% (测试条件不变时)	<b>≤±0.2%</b> (测试条件不变时)	<b>≤±0.2%</b> (测试条件不变时)

不同光谱范围设备测试数据

	ModuleMar	Temperatu	Voc	Isc	Pmax	Vm	Im	FF	$\eta$ _Cell	$\eta$ _Module	TestTime
400-1100	sn_67	17	47.80581	9.468224	351.431824	38.75644	9.0677	77.64114	20.0567	21.60158	16:05:55, Nov 08, 2016
	sn_68	17	47.82175	9.468856	351.519257	38.7642	9.068141	77.6294	20.06169	21.60696	16:06:06, Nov 08, 2016
	sn_69	17	47.8037	9.459897	351.364563	38.765	9.063965	77.69804	20.05286	21.59745	16:06:18, Nov 08, 2016
	sn_70	17	47.76095	9.465132	351.39624	38.75412	9.067326	77.73159	20.05467	21.5994	16:06:29, Nov 08, 2016
	sn_71	17	47.80842	9.463328	351.310974	38.75443	9.065054	77.65035	20.0498	21.59415	16:06:41, Nov 08, 2016
	sn_72	17	47.80861	9.467894	351.383636	38.74714	9.068634	77.62866	20.05395	21.59862	16:06:52, Nov 08, 2016
AVE					351.4010823						

300-1200	sn_105	17	48.04772	9.464021	354.680206	39.01565	9.090716	77.9989	20.24209	22.7651	16:05:34, Nov 08, 2016
	sn_106	17	48.04923	9.458359	354.710663	39.01821	9.0909	78.04984	20.24382	22.76705	16:05:45, Nov 08, 2016
	sn_107	17	48.04633	9.461088	354.724335	39.00908	9.093379	78.03503	20.2446	22.76793	16:05:56, Nov 08, 2016
	sn_112	17	48.02732	9.459043	354.749969	38.97419	9.102177	78.08846	20.24607	22.76958	16:06:52, Nov 08, 2016
	sn_113	17	48.01907	9.460574	354.723938	38.97251	9.101901	78.0835	20.24458	22.7679	16:07:03, Nov 08, 2016
AVE					354.7178222						

数据融合、消除硬件差别，从未如此畅快



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自由设定输出类型与格式



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02 感谢赫爽公司

03 感谢我的团队

# 感谢聆听

THANK YOU TO LISTEN TO CRITICISM GUIDANCE

赫爽太阳能永远是您最信赖的合作伙伴

