# Encapsulation Solutions

for

# TOPCon PV Modules

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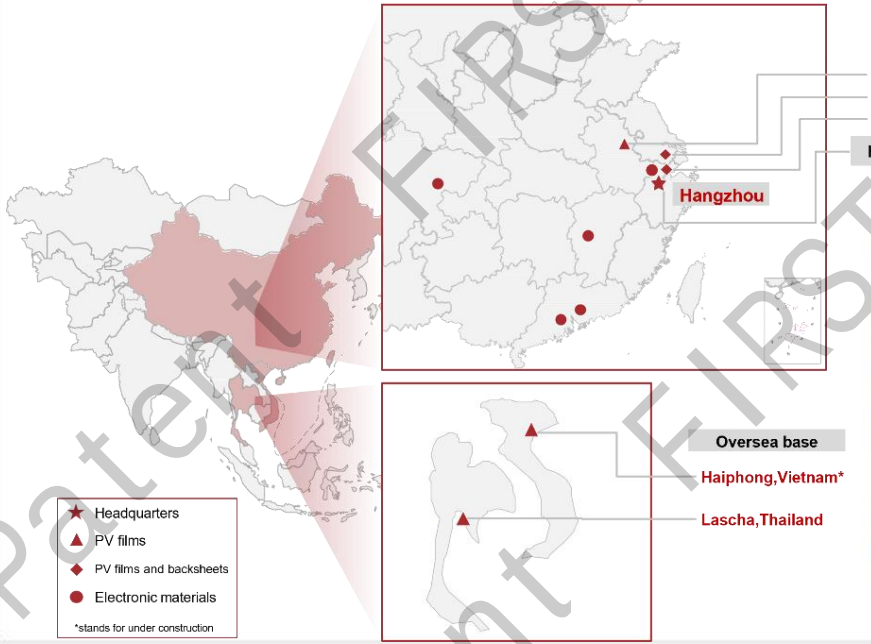
HANGZHOU FIRST APPLIED MATERIAL CO., LTD.

# Global Operation bases and Capacity

- 4 x Production Bases in China
- 2 x Overseas Production Bases
- Annual Production Capacities : 400GW of Encapsulants, 50GW of Backsheet




总部 Headquarters

Thailand

Vietnam

# Chapter 2

# Encapsulation for Glass-Glass TOPCon Modules

# DH Test : TOPCon G2G with different encapsulant combinations

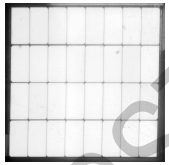
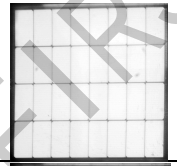
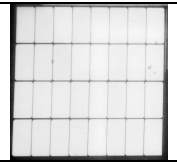
| Encapsulant | DH Test | Voc [V] | Isc [A] | F.F. | Pmax [W] | Power loss |
|---|---|---|---|---|---|---|
| F406PS+F406PS normal 【EVA+EVA】 | Initial | 53.17 | 13.57 | 0.81 | 587.06 | |
| | DH1000h | 53.01 | 13.40 | 0.81 | 573.99 | 2.23% |
| | **DH1500h** | **53.04** | **13.29** | **0.78** | **552.77** | **5.84%** |
| | **DH2000h** | **53.01** | **13.28** | **0.72** | **503.58** | **14.22%** |
| **S406(P)+S406(P)** Low acid + PID enhance 【EVA+EVA】 | Initial | 53.11 | 13.50 | 0.81 | 584.02 | |
| | DH1000h | 52.92 | 13.38 | 0.81 | 573.64 | 1.78% |
| | **DH1500h** | **53.01** | **13.36** | **0.80** | **568.59** | **2.64%** |
| | **DH2000h** | **52.97** | **13.30** | **0.78** | **548.42** | **6.10%** |
| EP304+F406PS 【EPE+EVA】 | Initial | 53.15 | 13.62 | 0.81 | 587.23 | / |
| | DH1000h | 52.98 | 13.42 | 0.81 | 576.00 | 1.91% |
| | DH2000h | 53.01 | 13.46 | 0.80 | 571.90 | 2.61% |
| | DH3000h | 53.04 | 13.42 | 0.79 | 563.65 | 4.02% |
| EP304+EP304 【EPE+EPE】 | Initial | 53.18 | 13.54 | 0.82 | 586.93 | / |
| | DH1000h | 53.08 | 13.41 | 0.81 | 577.76 | 1.56% |
| | DH2000h | 53.13 | 13.41 | 0.81 | 575.05 | 2.02% |
| | DH3000h | 53.18 | 13.4 | 0.80 | 572.83 | 2.40% |
| TF4+TF4 【POE+POE】 | Initial | 53.20 | 13.56 | 0.82 | 587.79 | / |
| | DH1000h | 53.07 | 13.45 | 0.81 | 578.93 | 1.51% |
| | DH2000h | 53.19 | 13.40 | 0.81 | 577.08 | 1.82% |
| | DH3000h | 53.11 | 13.40 | 0.81 | 575.58 | 2.08% |

**TOPCon LECO cell A : Jan 2024 Lot**

- ✓ **Power loss of TOPCon G2G modules with EPE and POE were <3% after DH3000**
- ✓ **When TOPCon G2G modules were encapsulated with S406(P) EVA (Low acid + PID enhance)**
  - **6.1% Power loss after DH2000**
  - **Still better than normal EVA**
- ✓ **This DH test results of TOPCon G2G modules are consistent with the water vapor barrier ability of the encapsulation film**

  **WVTR: POE < EPE < EVA**

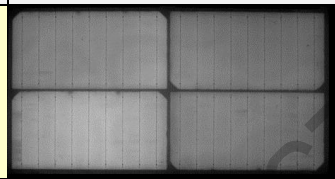
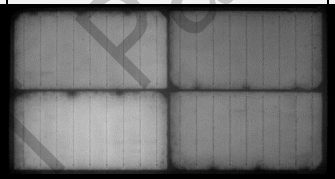
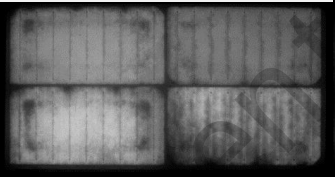
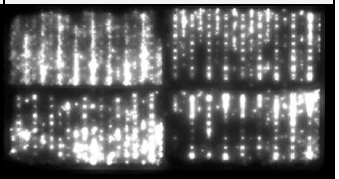
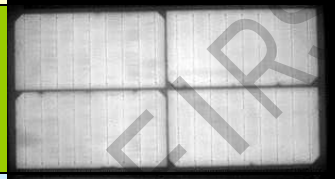
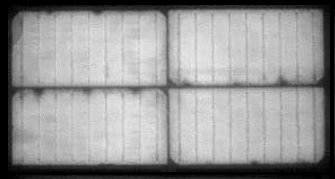
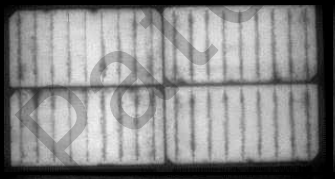
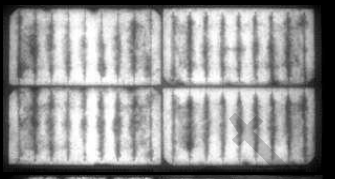
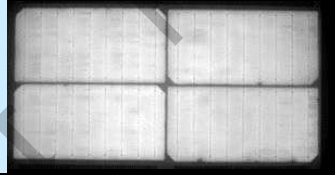
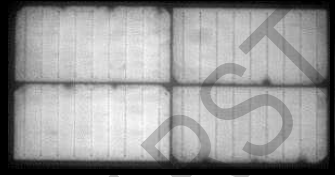
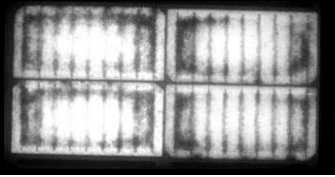
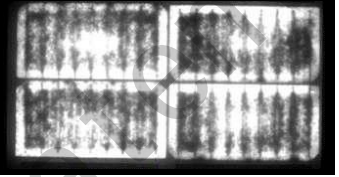
# PID results of TOPCon G2G

| Encapsulant combination | Inital | PID 96h | | PID 192h | | PID288h | |
|---|---|---|---|---|---|---|---|
| | | before recovery | UV2kWh | before recovery | UV2kWh | before recovery | UV2kWh |
| 【EVA+EVA】<br>F406PS+F406PS : normal |  | ↓ 20.74% | ↓ 0.62% | ↓ 28.10% | ↓ 2.24% | ↓ 28.77% | ↓ 5.80% |
| 【EVA+EVA】<br>S406(P)+S406(P)<br>Low acid + PID enhance |  | ↓ 21.45% | ↓ 0.33% | ↓ 27.70% | ↓ 0.85% | ↓ 28.51% | ↓ 2.31% |
| 【EPE+EVA】<br>EP304+F406PS |  | ↓ 0.34% | / | ↓ 0.67% | / | ↓ 1.32% | / |
| 【EPE+EPE】<br>EP304+EP304 |  | ↓ 0.29% | / | ↓ 0.66% | / | ↓ 1.27% | / |

# Chapter 3

# Encapsulation for Glass-Backsheet TOPCon Modules

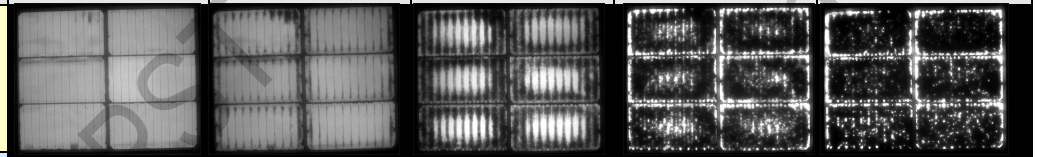
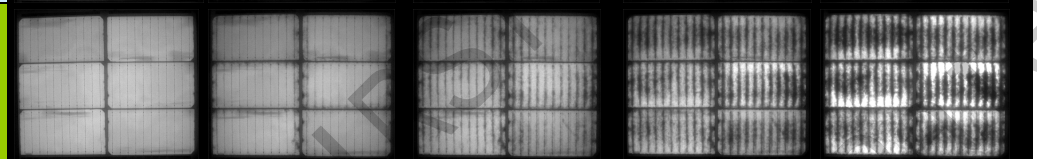
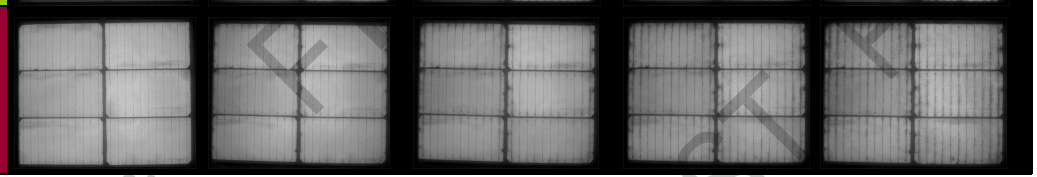
# N-TOPCon G2B modules with conventional encapsulants

| Front | Initial | PCT 48h | PCT 96h | PCT 144h |
|---|---|---|---|---|
| EVA |  |  |  |  |
| POE |  |  |  |  |
| EPE |  |  |  |  |

- Corrosion Rate : EVA≈ EPE > POE
- Even POE film still have a significant risk of corrosion

# TF4N : Encapsulation Solution for N-TOPCon G2B modules

➢ **TF4N POE on the front side : The best solution for N-TOPCon G2B modules**

| | PCT0 | PCT48 | PCT96 | PCT144 | PCT192 |
|---|---|---|---|---|---|
| EVA |  | | | | |
| EPE |  | | | | |
| Competitor POE |  | | | | |
| TF4N POE |  | | | | |

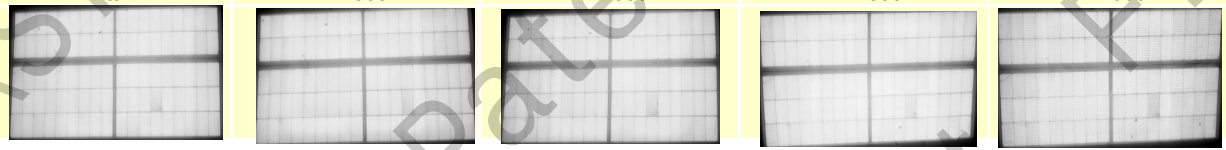
- Rear Encapsulant : F806W (white EVA)
- Backsheet：CPC white
- PCT：121℃ / 85%RH

# TF4N : DH test results

TF4N + F806W + CPC white

| DH | Test Side | Voc [V] | Isc [A] | Vmax [V] | Imax [A] | Pmax [W] | F.F. | Temperature[°C] | Power Loss [%] |
|---|---|---|---|---|---|---|---|---|---|
| inital | front | 32.12 | 13.23 | 26.50 | 12.55 | 332.46 | 0.78 | 24.3 | / |
| 500 | front | 32.26 | 13.33 | 26.32 | 12.61 | 332.05 | 0.77 | 25.1 | 0.13 |
| 1000 | front | 32.15 | 13.30 | 26.39 | 12.60 | 332.67 | 0.78 | 24.3 | -0.06 |
| 1500 | front | 32.09 | 13.31 | 26.11 | 12.57 | 328.21 | 0.77 | 23.5 | 1.28 |
| 2000 | front | 32.13 | 13.35 | 25.58 | 12.38 | 321.70 | 0.75 | 25.1 | 3.24 |

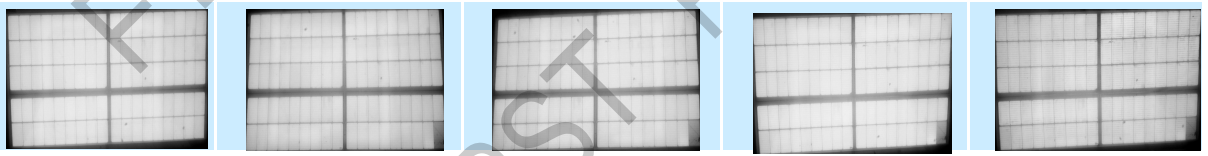
Front side EL




TF4N + S806 + CPC black

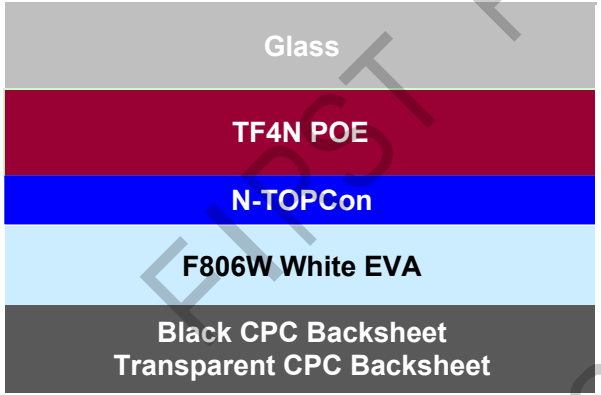
| DH | Test Side | Voc [V] | Isc [A] | Vmax [V] | Imax [A] | Pmax [W] | F.F. | Temperature[°C] | Power Loss [%] |
|---|---|---|---|---|---|---|---|---|---|
| inital | front | 32.08 | 12.88 | 26.53 | 12.20 | 323.58 | 0.78 | 24.3 | / |
| 500 | front | 32.23 | 12.97 | 26.38 | 12.24 | 322.96 | 0.77 | 25.1 | 0.19 |
| 1000 | front | 32.08 | 12.93 | 26.40 | 12.23 | 322.92 | 0.78 | 24.3 | 0.21 |
| 1500 | front | 32.01 | 12.94 | 26.09 | 12.19 | 318.07 | 0.77 | 23.5 | 1.70 |
| 2000 | front | 32.08 | 12.99 | 25.57 | 12.04 | 312.54 | 0.75 | 25.1 | 3.41 |

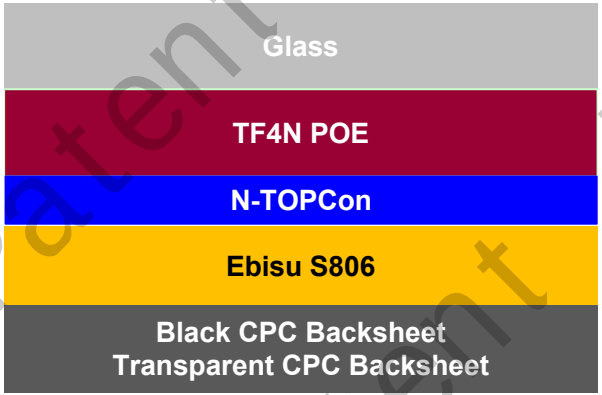
front side EL




- Both can pass twice the IEC test standard value

# Encapsulation Solutions for TOPCon G2B modules




**Competitive cost and reliability solution!**

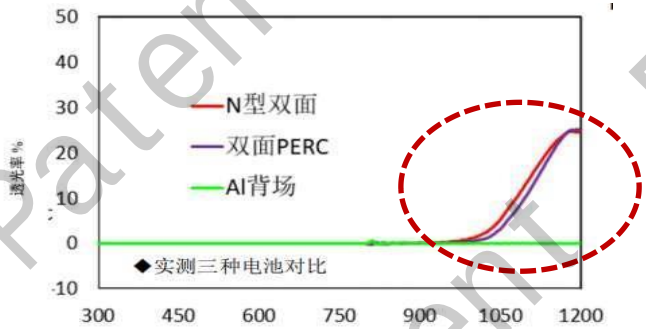
# Chapter 5

# High Reflective (HR) Black Backsheet

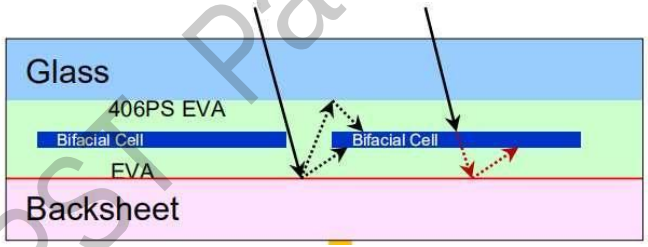
# High Reflective Black Backsheet (HRBB)

- **High Reflective Black Backsheet is using non-metallic pigment system**
- **Reflect through cell-to-cell gap and transmission : Power boost**

Module Appearance with High Reflective Black Backsheet



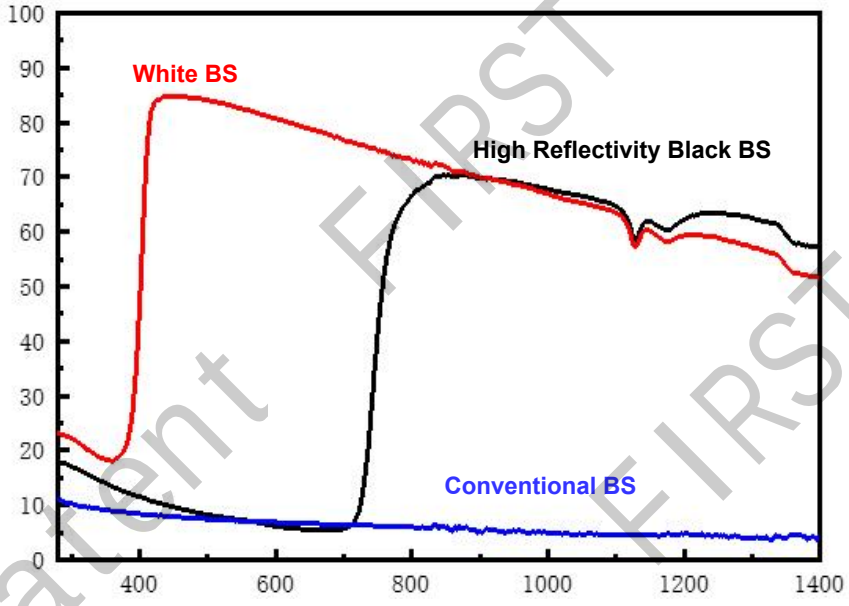

**Light transmittance of the cells**

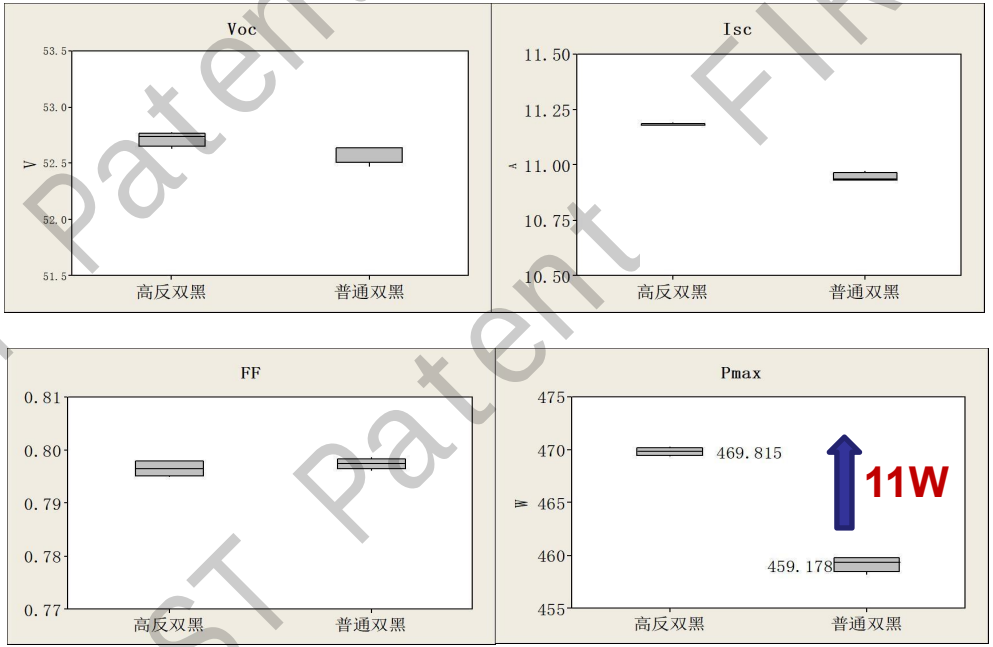



**Infrared light utilization path**

# High Reflective Black Backsheet (HRBB)

- **High Reflectance at Infrared region : ≥70%**
- **Power gain ≥2% (more than 5 W)**




78 cells N-Topcon module between HRBB and common BB

## Contact

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