



Product Reliability Challenges due to Packaging in A-Si Thin Films Modules

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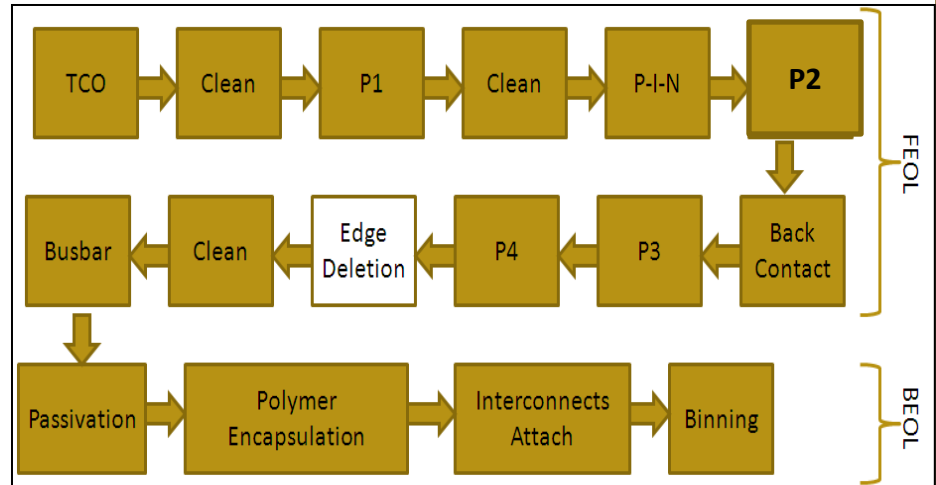


Introduction

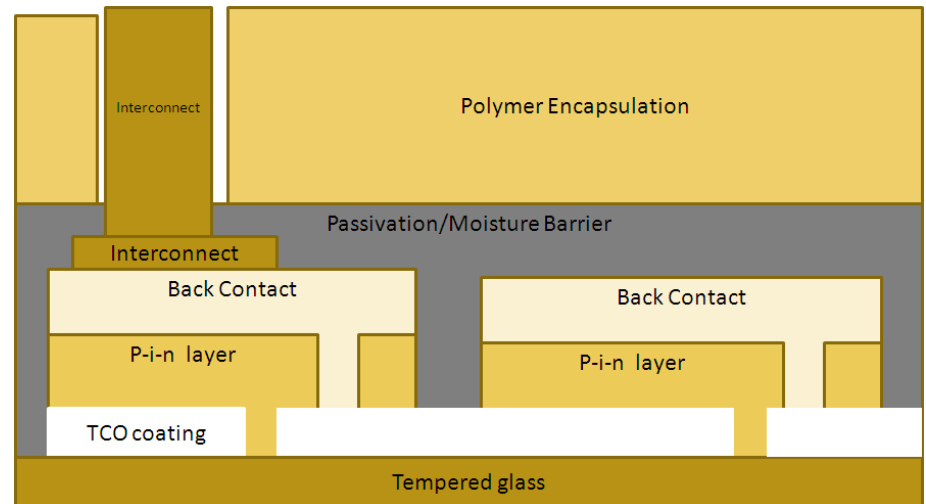
Packaging of the thin film modules is a significant contributor for the product reliability in the field.

We found that the contributions of the edge deletion methodologies on the module reliability is paramount and contributes to the long term performance of the module.

Effects of temperature, voltage, moisture, current, and were studied on the modules with edge deletion both Sand Blast Techniques and Laser Based Techniques



Novasolar's Continuous Module Production Process



Novasolar's Module Construction

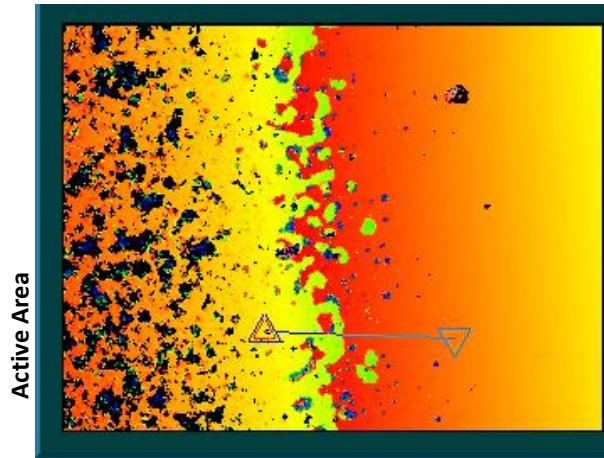
Key Reliability Challenges – Edge Deletion Using Sand Blasting

Novasolar found Sand Blasting Technique causing the

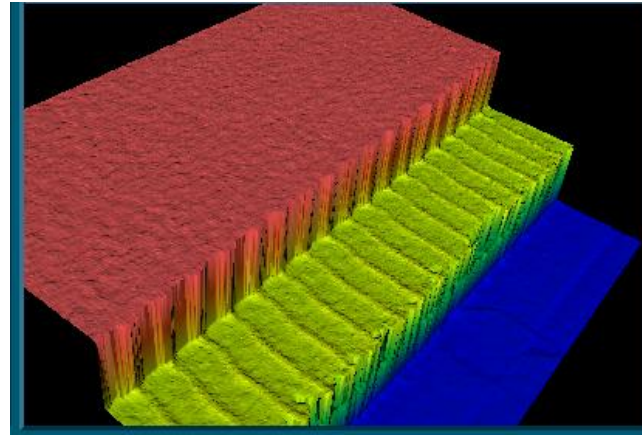
1. Delamination of Encapsulation during accelerated stress testing
2. Failures caused due to delamination of the encapsulation and moisture ingress
3. Field Failures caused due to delamination in the active area
4. Random module breakages in the field

Edge Finish Comparison Sand Blast Vs. LED

Sand blast ED Process

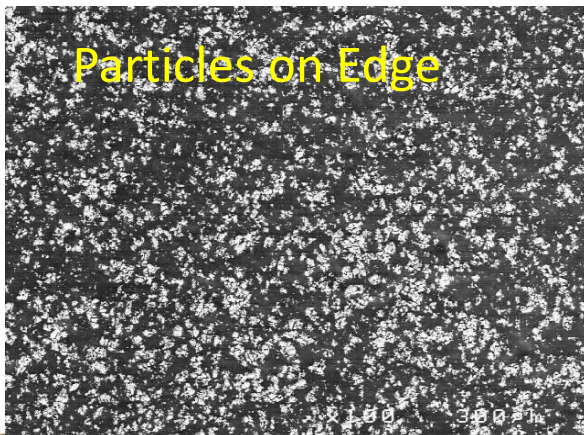


Laser ED Process

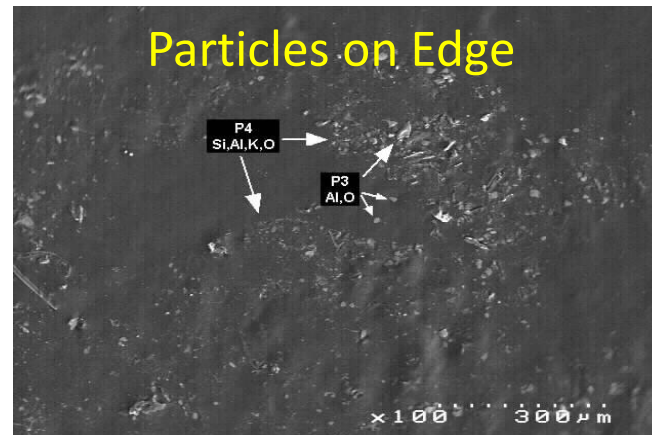


Sand Blast caused a very rough and contaminated edge unlike Laser Edge Deletion Method causing adhesion issues for the polymer encapsulation and causing Delamination

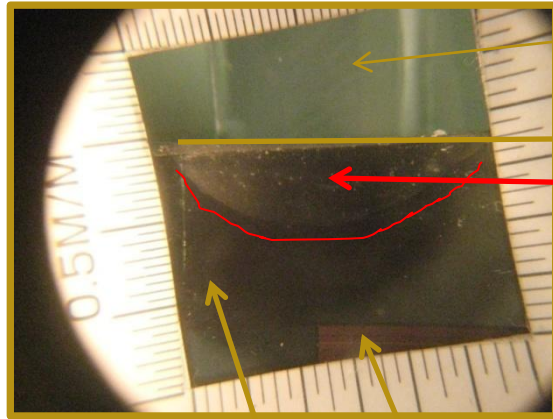
Particles on Edge



Particles on Edge



Edge Delamination Post Accelerated Testing



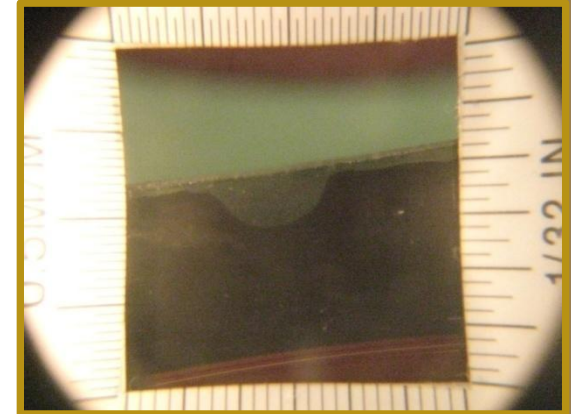
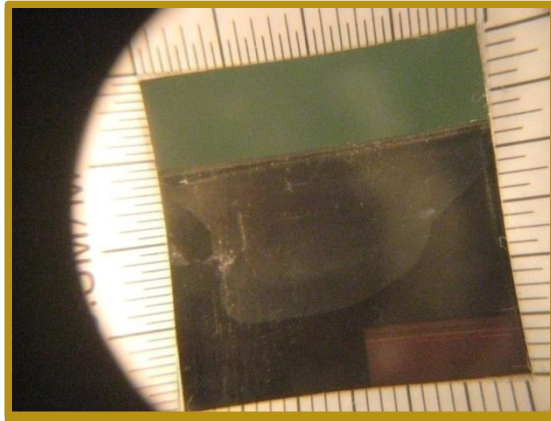
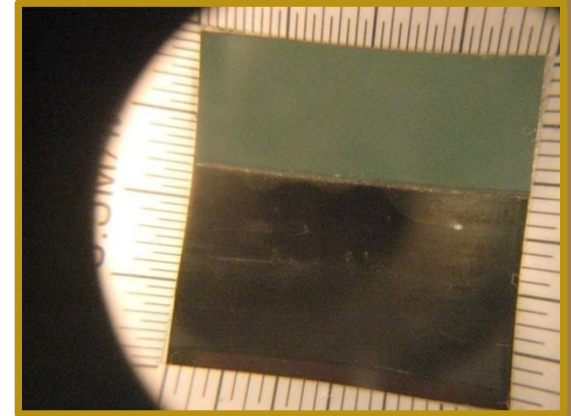
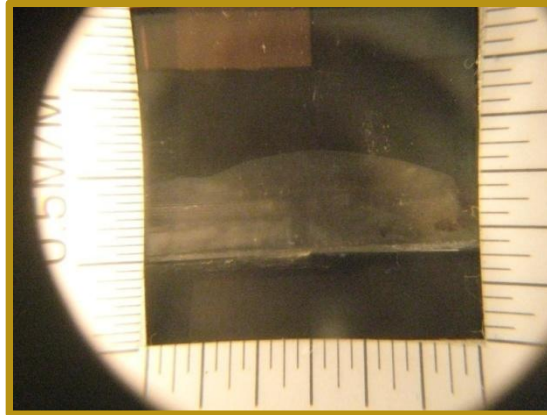
background

module edge

Edge delamination

Intact edge

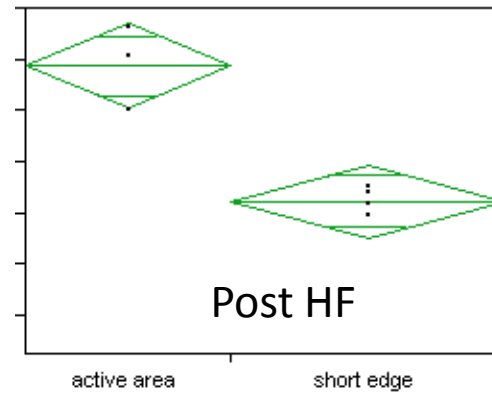
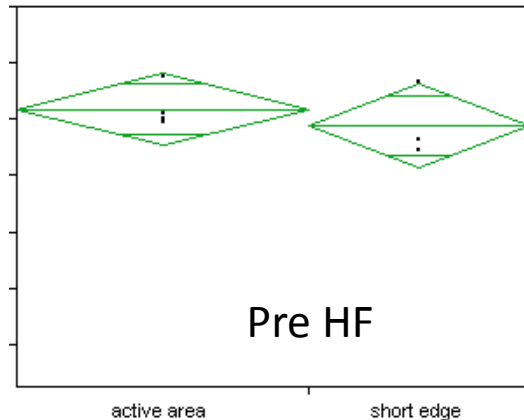
Active area



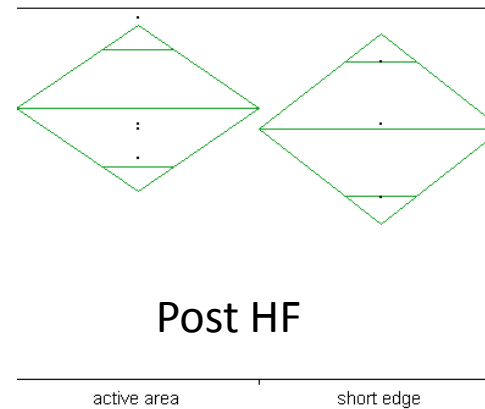
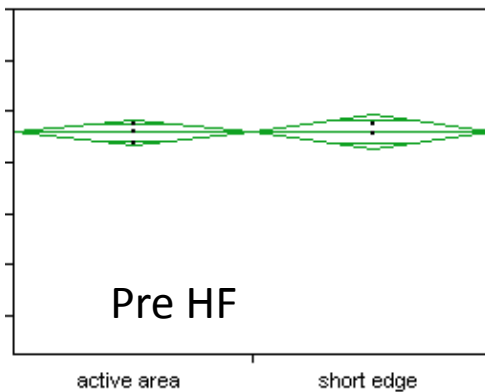
Polymer peel off due to poor adhesion & Contamination Post HF

Adhesion of the Encapsulation to the Stack : Mechanical Pull Experiments

Sand blast ED Process



Laser ED Process



Lower Adhesion on the edge of the modules found caused due to the Sand Blast's rough and contaminated edges and the same effect amplified post accelerated stress testing

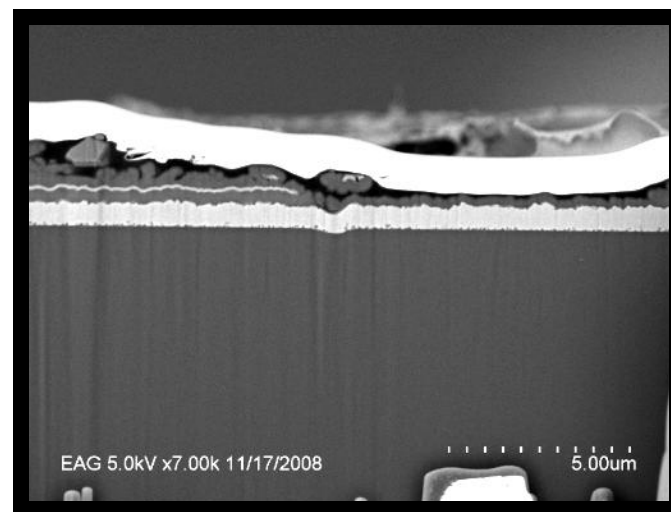
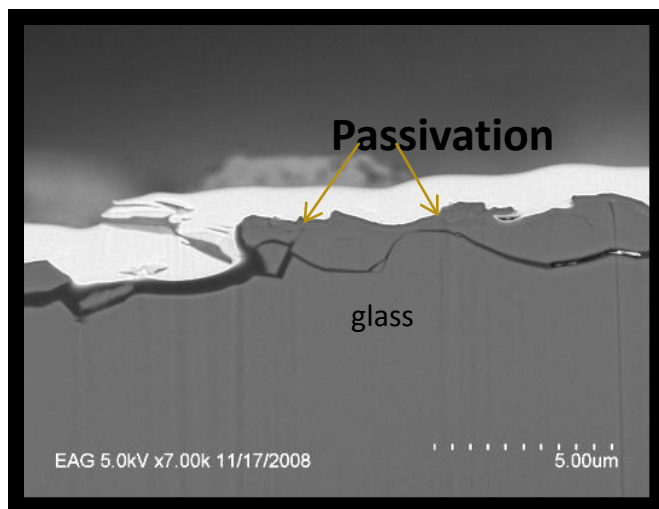
Mechanical Testing : Rupture Test Results



Sr. No.	Sample	Condition	Breaking Load (lbs)	Breaking Stress (lbs/cm ²)	Breaking Stress (lbs/in ²)
1	Sand Blast	Temp40_RH80	222	3088.02	19922.67
2	Laser Edge Deletion	Temp40_RH80	267	3713.97	23961.05
3	Sand Blast	Temp80_RH80	229	3185.39	20550.86
4	Laser Edge Deletion	Temp80_RH80	272	3783.52	24409.76
5	Laser Edge Deletion	Room Conditions	289	4019.99	25935.37
6	Laser Edge Deletion	Room Conditions	283	3936.53	25396.92
7	Sand Blast	Room Conditions	208	2893.28	18666.29
8	Plain Glass	Temp40_RH56	264	3672.24	23691.82

Glass Micro-cracks due to Sanblast Edge Deletion Causing Poor Adhesion and Lower Module Strengths

Glass Micro cracks due to Sand Blasting

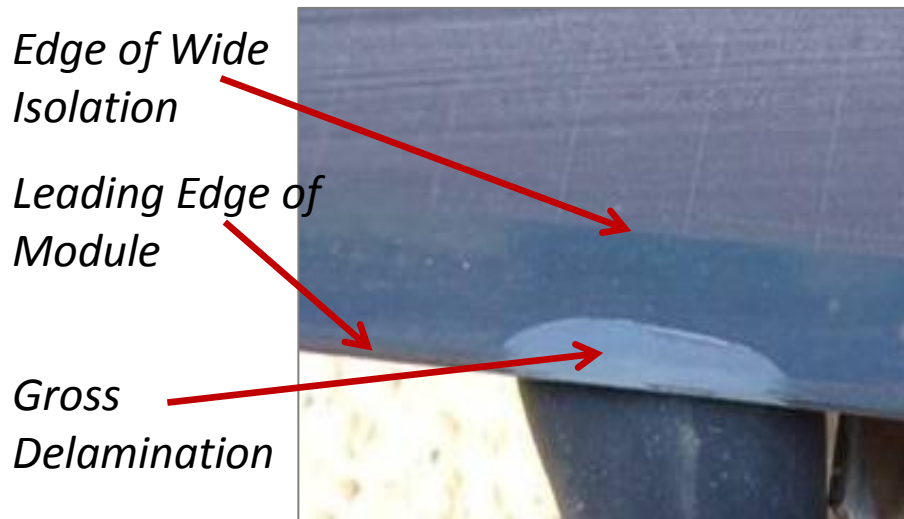


Glass Micro-cracks due to Sanblast Edge Deletion Causing Poor Adhesion and Random Module Breakages in the Field

Delamination in Field Caused Due to Contamination from Sand Blast & Resulting Poor Encapsulation Adhesion

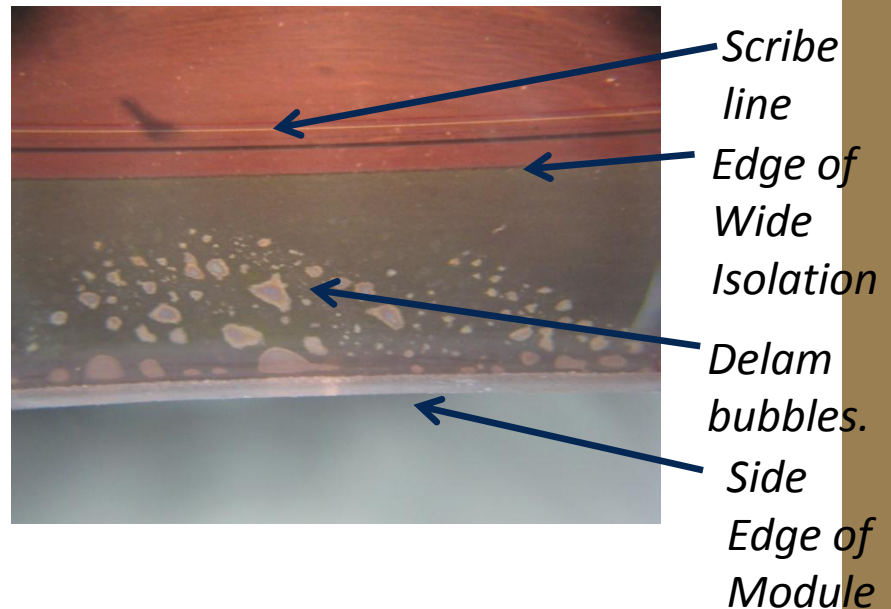
Gross Delamination

- Continuous from edge
- Large scale (> 10mm width)
 - Rarely more than 5mm deep



Bubble Delamination

- Not continuous
- Individually small (< 5mm)



Arcing Effects Due to Sand Blasting



Arcing effects observed across isolation scribe due to pockets of un-removed TCO in the edge area - Issue found in the field



Arcing effects observed across isolation Scribe due to pockets of un-removed TCO in the edge area – Issue Simulated in the Lab during Accelerated Stress Testing

Conclusions

- Novasolar has found both by accelerated stress tests and field exposure tests that Sand Blasting used for Edge Deletion contributes negatively to the module reliability and long term performance
- Seeing the effects of Sand Blast Technique, Novasolar Technologies switched to Laser Based Techniques on the production lines and saw a significant improvement in the module reliability performance



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