New Back Side Tabbing Paste for PERC Application with Improved Passivation Layer Protection

Yi Yang, Devidas Balu Raskar, Guang Zhai, Lindsey Karpowich, Chilong Chen, Weiming Zhang
Table Content

- Introduction
  - Standard tabbing paste vs. PERC tabbing paste

- Technical Challenges
  - Voc gain vs. high adhesion

- Heraeus Technical Solution
  - Glass reaction with SiNx
  - Additives to improve adhesion and further protection for passivation layer
  - Engineered glass/Ag

- Heraeus New PERC Tabbing Paste
  - SOL326 product portfolio
  - SOL326 performance on different customer cells

- Summary
INTRODUCTION

Traditional Tabbing vs. PERC Tabbing

- **Passivated Emitter and Rear Cell:** high-quality oxide as BS passivation
  - Localized rear contacts and LBSF formed at laser-fired openings in passivation
  - Reduced recombination losses and increase in internal reflectance at the rear
  - Improved Voc and Isc → much improved Efficiency

- Tabbing paste on the BS should not fire through the passivation layers!

**Standard solar cell**

- Screen-printed Ag-paste
- Screen-printed Al-paste
- Back Surface Field

**PERC solar cell**

- ARC
- Local BSF
- Passivation layer
- SiNₓ capping layer

**PL → Recombination at BS tabs**

**PL → Improved Non-contact**

---

http://www.isfh.de/institut_solarforschung/industrienahe-siebdrucksolarzelle.php?_l=1

Yi Yang | HPT Innovation | May 23, 2016
Low activity PERC tabbing pastes

### Customers wish list
- High Voc/Isc leads to high cell efficiency
- High adhesion and aged adhesion for long term reliability
- Wider firing window, especial at low temperature to maximize PERC Al performance
- Wider soldering window: different ribbon, different flux, different soldering temperature
- Cheap price: low Ag content

### Technical challenge to paste maker
- Voc and adhesion often don’t follow the same trend
- High aged adhesion requires more control reaction: Ag/glass/Al/wafer surface + solder ribbon
- Low temperature firing is challenge for high adhesion
- Low Ag content is challenge for high reliability
TECHNICAL CHALLENGE OF PERC TABBING

How do we achieve a platform that will put us in the “green quadrant”?

Relation of glass structure with measured adhesion and Voc

Properties that promote good adhesion are detrimental to Voc and passivation!
SOL326 offers better Voc, Eta and higher aged adhesion

Technical solutions in SOL326

- New glass chemistry offers better passivation: low reactivity with passivation layer
- Engineered Ag offers better sintering at wider firing window
- New additive offers better aged adhesion with improved protection on passivation layer
- Wider range product portfolio meets customer expectations
  - Ag contents from 45% to 65%
    - Ag% higher than 65% are categorized in non-contact BB production series
- SOL326 showed 1.5-2.5 mV higher Voc than SOL325
Variation of glass/additive/Ag system offers solution for different customers’ passivation technology

Wider Ag content range meets different customers’ cost strategy

Non-contact property is not only solutions for PERC tabbing, but also solutions for other structures requiring non-contact property, e.g. N-type
SOL326 offers better protection on passivation layer

SEM imaged showed SOL326 has less ARC damage on both mono/multi wafers.
SOL326 PERFORMANCE

Higher Voc, higher Eta on customer wafer A

Inactive (dark) regions surrounding the EL probes indicate that SOL326C is not firing through the backside passivation layer

SOL326B showed 1.7-2.5 mV higher Voc than SOL325A

Customer A results

<table>
<thead>
<tr>
<th></th>
<th>PMPP</th>
<th>Voc</th>
<th>JSC</th>
<th>FF</th>
<th>ETA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOL325A</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>SOL326</td>
<td>0.43%</td>
<td>0.12%</td>
<td>0.15%</td>
<td>0.15%</td>
<td>0.45%</td>
</tr>
</tbody>
</table>

Data by R. Tavares
SOL326 showed higher Voc on different customer PERC wafers

- SOL326 showed 2-3 mV Voc gain than SOL325 on different customers’ PERC cells.
- SOL326 samples behave slightly differently on different customer PERC wafers

We can maximize your cell efficiency based on your passivation property!

**Customer D results**

EL results indicated low damage of passivation from SOL326Q
SOL326 PERFORMANCE

SOL326 performance on customer wafer F

- SOL326 series offer higher Voc, Isc and Eta than SOL325M.
  - Customer results confirmed?
- SOL326 showed wider firing window
  - Lower firing temperature showed comparable performance
- SOL9631C/SOL326 offers solution for PERC

![Boxplot of Eta, Isc, and Voc for SOL326 on customer wafer F](image)

<table>
<thead>
<tr>
<th>Comment</th>
<th>Amount</th>
<th>Eta</th>
<th>Isc</th>
<th>Voc</th>
<th>FF</th>
<th>Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS21_1086 - BSL</td>
<td>90</td>
<td>0.039</td>
<td>0.003</td>
<td>0.0008</td>
<td>0.029</td>
<td>-0.000050</td>
</tr>
</tbody>
</table>
SOL326S offers comparable adhesion and much higher aged adhesion than SOL325M.

**Boxplot of Standard and Aged Adhesion**

- **Adhesion (N)**
  - Aged PXI-20: 3.26144
  - Aged PXI: 3.05289
  - Aged 325M: 2.00833
  - Aged 326S: 3.11271
  - Standard PXI-20: 0.8805
  - Standard PXI: 1.882
  - Standard 325M: 3.42471
  - Standard 326S: 3.44835

**Worksheet:** Worksheet 3; 5/13/2016
SUMMARY

SOL326 offers better Voc, Eta and higher aged adhesion

- SOL326 series showed 1.5-2.5 mV gain over SOL325 series on different customers’ PERC wafers
  - Low reactivity glass in SOL326 offers better passivation protection
  - Engineered Ag offers better sintering at wider firing window: similar Eta and Voc was observed at lower firing temperature
  - New additive offers better aged adhesion with improved protection on passivation layer:
- Lower Ag content SOL326B,C showed comparable Voc and Eta performance as SOL326S/Q.
- SOL326 offers higher aged adhesion than SOL325, indication of better reliability

THANK YOU!
Yi Yang
R&D Scientist
Non-contact DP/Dual P BB and tabbing paste project leader
Heraeus Photovoltaic Business Unit, Innovation

Heraeus Precious Metals North America Conshohocken LLC
24 Union Hill Road
West Conshohocken, PA 19428

Yi.Yang@heraeus.com
+1 (610) 825-6050 ext. 276
+1 (215) 429-6593