Assembly and wire bonding of the ALICE SPD

- Half-stave layout
- Half-stave assembly procedure
- Glue overview and test
- Wire-bonding
Half-stave layout

see P. Riedler talk

About 200 half-staves are needed (120 for the detector + spares)

R. Santoro for ALICE SPD group
Glue characteristics

✓ Electrical insulating
✓ Thermal conductive
✓ Cured at room temperature
✓ Smooth for a proper gluing under the wire-bonding pads of the carrier bus
✓ Elasticity modulus such as to guarantee minimal mechanical stress
✓ Good workability with dispenser or mask use (~ 100 mm)
## Glue Overview and Test

<table>
<thead>
<tr>
<th>Producer name</th>
<th>Glue Name</th>
<th>Application / description</th>
<th>Properties</th>
<th>Thermal Conductivity (W/m°C)</th>
<th>Curing</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAVID Thermalloy</td>
<td>thermalbond</td>
<td>Epoxy</td>
<td>electrical insulating</td>
<td>1.34</td>
<td>room temperature</td>
</tr>
<tr>
<td>paltier technik</td>
<td>NEE001</td>
<td>silicon</td>
<td>electrical insulating</td>
<td>0.2</td>
<td>room temperature</td>
</tr>
<tr>
<td>Emerson cuming</td>
<td>Eccobond 45</td>
<td>Epoxy</td>
<td>electrical insulating</td>
<td>0.35</td>
<td>room temperature</td>
</tr>
<tr>
<td></td>
<td>flexible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cookson Electronics</td>
<td>Staystik 442</td>
<td>Thermoplastic film</td>
<td>electrical insulating</td>
<td>0.25</td>
<td>100 - 150°C</td>
</tr>
<tr>
<td>Cookson Electronics</td>
<td>Staystik 343</td>
<td>Thermoplastic paste</td>
<td>electrical insulating</td>
<td>0.25</td>
<td>100 - 150°C</td>
</tr>
<tr>
<td>Loctite</td>
<td>384</td>
<td>Epoxy paste</td>
<td>electrical insulating</td>
<td>0.75</td>
<td>room temperature</td>
</tr>
<tr>
<td>Ciba-Geigy</td>
<td>Araldite 2001</td>
<td>Epoxy</td>
<td>electrical insulating</td>
<td>0.22</td>
<td>room temperature</td>
</tr>
</tbody>
</table>
Elasticity test of Eccobond 45 (I)

**Surfaces glued**

**Strength**

**Fixed points**

**Micrometer**: it is used for the measurement of the skidding between the surfaces.

**Glue under test**: this is the point were one of the two surfaces is fixed.

**Mechanical stress system**: a system with pulley, wire and load fixed to the other glass surface to stress the glue.
Elasticity test of Eccobond 45 (II)

$\Delta x/h$ measures the ratio between the displacement of one surface to the other and the thickness of the glue layer

**Our results**

- Tangential stress $E45$: different samples

<table>
<thead>
<tr>
<th>Stress</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.42 N/mm²</td>
<td>3 gg (100 micron) bad glue (ATLAS)</td>
</tr>
<tr>
<td>1.18 N/mm²</td>
<td>4 gg (100 micron) Bari glue</td>
</tr>
</tbody>
</table>

**ATLAS results**

- Tangential elasticity

<table>
<thead>
<tr>
<th>Stress</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.62 N/mm²</td>
<td></td>
</tr>
<tr>
<td>0.68 N/mm²</td>
<td></td>
</tr>
<tr>
<td>0.86 N/mm²</td>
<td></td>
</tr>
</tbody>
</table>

R. Santoro for ALICE SPD group
Thermal stress of Eccobond 45

- **Eccobond 45 removable above 60 °C**
- **Detachment at high temperatures? Tests of thermal stress performed**

### Test 1 (no load)

<table>
<thead>
<tr>
<th>Temperature range (°C)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>28° - 48°</td>
<td>10’ 30’’</td>
</tr>
<tr>
<td>48° - 68°</td>
<td>8’ 30’’</td>
</tr>
<tr>
<td>68° - 88°</td>
<td>5’ 40’’</td>
</tr>
<tr>
<td>88° - 98°</td>
<td>7’ 30’’</td>
</tr>
<tr>
<td>112°</td>
<td></td>
</tr>
</tbody>
</table>

### Test 2 (5 gr load)

<table>
<thead>
<tr>
<th>Temperature range (°C)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>61° - 71°</td>
<td>3’</td>
</tr>
<tr>
<td>71° - 81°</td>
<td>3’</td>
</tr>
<tr>
<td>81° - 91°</td>
<td>2’ 30’’</td>
</tr>
<tr>
<td>91° - 101°</td>
<td>3’</td>
</tr>
<tr>
<td>125°</td>
<td></td>
</tr>
</tbody>
</table>

R.Santoro for ALICE SPD group

Sensor temperature

Conductive support

Ladder glued on the multilayer bus

Heating plate

No detachment
Half-stave assembly procedure

Side view

Top view

Carrier bus

Extender bus
Coordinate Measuring Machine in Bari for half-stave assembly

Mitutoyo
CRYSTA APEX 9166
Half-stave dummy prototype: Based on bottom-up procedure

- This procedure allows the half-stave to lay always on the same tower: easy handling and good planarity (the grounding foil being the reference plane)

- This H_S (see below) assembled according to the bottom-up procedure with new tools and jigs (designed and built): quality of alignments at least comparable w.r.t. the baseline procedure.

Components of the new H_S:

- Grounding foil cut in Bari without windows (Al + kapton, 75 μm)
- 2 sensor ladders (320 μm thick) with no FE chips
- 1 dummy MCM done in Bari + extenders and optical fibers
- 1 multilayer foil (dummy carrier bus) cut in Bari
- Eccobond 45 for A and B gluing
Dummy Half-stave assembly (II)
Half-stave dummy assembly (III)

Alignment results:
- Error ~ µm for the two ladders alignment
- Error ~ µm for the MCM and its closest ladder alignment
- Error between the two ladder distance is ~ 10µm without marker
What has been done

- *US Power*, *US Time* and *Bond force* parameters have been optimised to allow mechanical strength >10 gr on the available version of the carrier bus.
- Investigation of the bonding layout has been performed.
- Study of an automatic bonding procedure.
- Electrical test set-up.

Wire bonding features:

- Wedge Bonding.
- Wire bonding between carrier bus (five layers) and silicon substrates.
- Aluminium 25\(\mu\)m diameter wire.
- 120 \(\mu\)m pitch.
- 103 wire bonding connections for each chip (\(\approx 1200\) connections for half-stave).
ALICE SPD wire-bonding needs a dedicated machine: funding and procurement of a FEK Delvotec 6400 currently ongoing in Bari.
Outlook on wire bonding activity

• New protocol to find the *US Power, US Time* and *Bond Force*
• Prototypes of carrier bus needed to complete wire-bonding test procedure.
• Systematic study on the loop optimisation to get reliable bonding for the final geometry.
• Glob top to mechanical protection of the wire bonding is under investigation