Flammability Testing of Adhesive and Applications
Part I: Overview FST Adhesives

3M - Dr. Elgimiabi & Dr. Spiekermann

Part II: Adhesive and Applications - Fire Property Testing

Sell - K. Bösser & D. Langer
Recently launched **3M** Aerospace Products
Void fillers and adhesives

<table>
<thead>
<tr>
<th>Product</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW 3450 FST</td>
<td>One-part low density void filler, designed for interior applications ( -55 °C to 80 °C)</td>
</tr>
<tr>
<td>SW 3550 B/A FST</td>
<td>Two-part void filler for interior panels; low viscosity, suitable for cartridge and dispensing system</td>
</tr>
<tr>
<td>SW 3460 HT FST</td>
<td>One-part high temperature resistant core filler, exterior and interior applications ( -55 °C to 135 °C)</td>
</tr>
<tr>
<td>SW 9300 B/A FST</td>
<td>Two-part adhesive, combining excellent FST and bonding properties</td>
</tr>
</tbody>
</table>
Aerospace & Aircraft Maintenance Department

3M™ Scotch-Weld™
9300 B/A FST
Development of flame retardant (FR) adhesive paste that will meet new interpretations of FAA Fire Testing Standards and replace SW 9323-2 B/A used at Sell GmbH

Product main Features:

- Very high mechanical strength
- Low viscosity to enable various application techniques (e.g. injection, brushing)
- Customized curing cycle (long pot life at RT)
- Free of halogen and antimony trioxide as flame retardants
Applications

- Panel bonding (e.g. mortise and tenon joints)
- Ditch and pot (bent panel applications)
- Bonding of edge protectors
- Insert bonding
Mechanical Properties

Overlap shear strength

- Test method: EN 2243 - 1
- Test substrates: clad aluminum 2024 T3
- Surface preparation: Optimized FPL
Mechanical Properties
Floating roller peel strength

- Test method: EN 2243 - 2
- Test substrates: clad aluminum 2024 T3
- Surface preparation: Optimized FPL
## Mechanical Properties

### Ageing and fluid resistance

<table>
<thead>
<tr>
<th>Condition</th>
<th>Duration</th>
<th>Overlap shear strength [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>N/A</td>
<td>34</td>
</tr>
<tr>
<td>demin. water</td>
<td>168 h</td>
<td>28</td>
</tr>
<tr>
<td>5% NaCl solution</td>
<td>24 h</td>
<td>32</td>
</tr>
<tr>
<td>95% r.h., 55 °C</td>
<td>168 h</td>
<td>25</td>
</tr>
<tr>
<td>Dry heat, 80 °C</td>
<td>24 h</td>
<td>30</td>
</tr>
<tr>
<td>Cold Soak, -55 °C</td>
<td>24 h</td>
<td>30</td>
</tr>
<tr>
<td>Coca Cola</td>
<td>24 h</td>
<td>28</td>
</tr>
<tr>
<td>Disinfectant (Lysol)</td>
<td>24 h</td>
<td>29</td>
</tr>
<tr>
<td>Methy ethyl ketone</td>
<td>1 h</td>
<td>30</td>
</tr>
</tbody>
</table>
## General Properties

<table>
<thead>
<tr>
<th>General Properties</th>
<th>Part B</th>
<th>Part A</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Brown</td>
<td>Off-white</td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>Epoxy</td>
<td>Modified amine</td>
<td></td>
</tr>
<tr>
<td>Consistency</td>
<td>Thixotropic paste</td>
<td>Thixotropic paste</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>1.2 g/cm³</td>
<td>1.2 g/cm³</td>
<td>EN 542</td>
</tr>
<tr>
<td>Viscosity</td>
<td>100 Pas</td>
<td>30 Pas</td>
<td>ISO 2555</td>
</tr>
<tr>
<td>Mix ratio by volume</td>
<td>100</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Cure cycle</td>
<td>2 hours at 65°C or 7 days at 23°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work life (a) at 23 ± 2°C</td>
<td>&gt; 3 hours</td>
<td>ISO 10364</td>
<td></td>
</tr>
<tr>
<td>Shelf life</td>
<td>6 months from date of shipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available packaging sizes</td>
<td>Cartridges: 400 ml duo-pack</td>
<td>Pails: 54 L kit, 280 L kit</td>
<td></td>
</tr>
</tbody>
</table>

(a) 45 g of mixed adhesive
Thank you for your attention!
One main objective for the development of the adhesive Scotch-Weld™ 9300 B/A FST was to prove, that

1) international Aerospace Certification and Industry Standards for Flammability, Heat Release, Smoke and Toxic Gases are met (e.g. CS/FAR 25.853, ABD0031, D6-51377)

2) latest requirements from Regulators are met in respective HC Panel applications (e.g. FAA Issue Paper on Flammability Compliance Methods, e.g. Ditch & Pot (DAP))

for the adhesive and its applications in composite structures for cabin interiors.
Total Quantity of Fire Property Tests performed with the new adhesive to prove the fireworthiness characteristics:

162 for material and respective applications

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Flammability (F1 and F2): Stand Alone &amp; Adhesive applications in bended HC Panels</td>
</tr>
<tr>
<td>54</td>
<td>Heat Release: Adhesive applied in HC Panel</td>
</tr>
<tr>
<td>54</td>
<td>Smoke Density and Toxic Gas Emissions: Adhesive applied in HC Panel</td>
</tr>
</tbody>
</table>
Bended Panel 5“ Radius (1“ & 3“ Radius not shown)
Flammability Test Sample
Adhesive Stand Alone - Brick

Stand Alone Sample 12“ x 3“ x 0.125“
Flammability Test Sample
Adhesive Stand Alone - Bar

Stand Alone Sample 0,5“ x 0,5“ x 12“
Flammability Test Video (F1)
Adhesive Stand Alone - Bar

Video starts 50s after Test start
Extinguishing time: 4s - No Drips - Burn Length: 0,5"
Flammability Test Results
Adhesive Stand Alone & Applications

Flammability Test Results

- **Burn Length [inch]**
- **Extinguishing Time [sec.]**
- **Drip Duration [sec.]**
Flammability Test Results
Adhesive Stand Alone & Applications

Test results demonstrate:

✓ Adhesive Applications and Stand Alone with comparable values

✓ Bended Panel Applications well below airworthiness limits
HC panels with different adhesive volume applied: 0,2 % / 1 % / 10 % to cover the complete range of constructions and Ditch and Pot-Applications.
Heat Release/Smoke Density/Toxic Gas Emission Test Sample Configuration

Adhesive Application 10% Volume - Rear Side shown
Test results demonstrate:

- No major affect through adhesive amount
- Front side (adhesive fully covered) reveals lower HR/HRR-values than rear side (open surface with adhesive)
Smoke Density Test Results
Adhesive Applications

Smoke Density Test Results

Blank Panel: 15
0.2 Vol% Front side: 45
0.2 Vol% Rear side: 77
1.0 Vol% Front side: 31
1.0 Vol% Rear side: 64
10.0 Vol% Front side: 34
10.0 Vol% Rear side: 62

Ds at 4 Min.
Test results demonstrate:

✓ Adhesive has major affect on Ds-values (but are still well below airworthiness limit)

✓ No increase of Ds-value by increase of adhesive amount

✓ Front side (adhesive fully covered) reveals lower Ds-values than rear side (open surface with adhesive)
Test results demonstrate:

✓ Adhesive has major affect on Gas Emission values (but are still well below industry limits)

✓ No increase of Gas Emission values by increase of adhesive amount

✓ Front side (adhesive fully covered) reveals lower Gas Emission values than rear side (open surface with adhesive) similar as blank panel
Conclusion

An appropriate range of adhesive & applications should be tested during the initial qualification and certification process

- to evaluate adhesive fireworthiness characteristics
- to understand adhesive fireworthiness affects
- to reduce fireworthiness risks for test failures
The Fire Property Tests performed show that the Scotch-Weld™ 9300 B/A FST meets

1) international Aerospace Certification and Industry Standards for Flammability, Heat Release, Smoke and Toxic Gas Emissions (e.g. CS/FAR 25.853, ABD0031, D6-51377),

2) latest requirements from Regulators are met in respective HC Panel applications (e.g. FAA Exemption No. 9791 for Ditch & Pot (DAP) flammability compliance issues)

in composite structure applications of cabin interiors.
Thank you for your attention!