Alcoa 951 Pretreatment Technology

-- Strengthening adhesive bonds between aluminum substrates to improve durability, allow mass production and minimize environmental impact for the automotive industry --

Andy Mills, Alcoa Global Rolled Products Center of Excellence

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Alcoa continues to pioneer aluminum in the automotive industry

Alcoa technology enabled the 1st Ford Model T over 100 years ago

1904
Alcoa builds Aluminum Auto Bodies for the Ford Model T in New Kensington, PA

Today, Alcoa 951 enabling High Volume Aluminum-Intensive Automobiles (AIV)

2013
2013 Aluminum Intensive Vehicle with Alcoa 951 Pretreatment
U.S. Corporate Average Fuel Economy (CAFE) Regulations require an increase in MPG from 27.2 in 2011 to 54.4 by 2025 (100% increase).

Need for lighter weight materials increases demand for Aluminum Intensive Vehicles (AIV).

**Drivers**

- Changing regulations create opportunities for Aluminum
- U.S. Corporate Average Fuel Economy (CAFE) Regulations require an increase in MPG from 27.2 in 2011 to 54.4 by 2025 (100% increase)
- Need for lighter weight materials increases demand for Aluminum Intensive Vehicles (AIV)

**Situation**

- Reliable, high performance and safe pretreatment required
  - Performance and cost requirements drive to adhesively bonded structures
  - High performance aluminum provides stiffer ride, continuous joint, and multi-material options
  - Untreated aluminum does not sustain structural integrity
  - Incumbent solutions posed environmental and safety hazards due to chrome content

**Solution**

- Alcoa 951 sets new global standard in adhesive bonding
  - Allows for durable, cost-effective, high-volume application
  - Eliminates chrome and heavy metals found in competing technologies

**Al structure with Alcoa 951**

Source: May 13, 2014 BOAML metals and Mining conference presentation
Alcoa drives differentiated product & sustainable growth

Customer Intimacy
- Strong links to customer technical community
- Understanding emerging customer needs
- Customized validation based on customer specs.

Technology Development
- Profound understanding of Al
- Refining around differentiated trade secrets
- Process development & scaling to minimize investment cost

Risk Mitigation
- Multiple layers of IP protection
- Patents
- Trade secrets relative to both chemistry & process
- Commercial partnership terms extending beyond patent expiration

Value Proposition
- Market technology on multiple forms of aluminum
- Establish as global standard for Al industry
- Supply partnership with leading chemical supplier
- Licensing agreement with competitor
**Alcoa 951 Description**

- Treatment for automotive structural adhesive bonding
- Protected by Alcoa patent/trade secret portfolio
- Completely organic in nature (cradle-to-cradle)
- Chemically tailors surface for dual capability
- Works at the oxide level (monomolecular)
- Effective on coil, extrusions and castings
- Doesn’t interfere with OEM manufacturing process steps
- Premium, robust bonding solution – **RISK MITIGATION**

**Alcoa 951 Surface Treatment Process**

- **Clean**
- **Deox**
- **Alcoa 951 pretreat**
- Immersion or spray

**Cyclic Durability Testing Results Vs. TiZr**

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<thead>
<tr>
<th></th>
<th>TiZr Vendor A</th>
<th>Alcoa 951</th>
<th>TiZr Vendor B</th>
<th>Alcoa 951</th>
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<tbody>
<tr>
<td>Customer #1 Trial</td>
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<td>Customer #2 Trial</td>
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- Alcoa 951 4x – 9x Stronger vs. TiZr

**Alcoa 951 Cyclic Exposure Specimens**

- Alcoa 951 60 exposure cycles
- Untreated failed at 6 exposure cycles
**Customer Needs**
- “Need a treatment to replace chrome”
- “Can’t interfere with other manufacturing steps”
- “Need short contact times for coil treatment”

1. **Initial version was an anodizing process**

2. **1st commercial use (truck cab)**
3. **1st commercial auto use (Europe)**

|------------|-----------|-----------|-----------|-----------|-----------|--------------|

**2014 R&D 100 Award Winner**
Alcoa 951 provides “Dual Activity” to the surface

Greatly reduces potential for interfacial failures

Tensile lap shear specimen

Alcoa 951 Pretreatment

Structural adhesive

One end of molecule “bonds” to oxide

Aluminum oxide

Alcoa 951 Pretreatment

Other end of molecule “bonds” to adhesive

Aluminum oxide

Aluminum Substrate
Alcoa 951 is transparent to OEM manufacturing flow path

**Does not interfere with stamping process**

**Able to resistance spot weld or rivet**

Accepts paint preparation

- Zinc phosphate
- Zirconium-based
- Siloxane-based
Alcoa 951 “Proves Itself” in bond durability exposure simulation

Bond Durability Exposure Cycle
- 15 min. salt water immersion (5% NaCl)
- 105 min. drip dry at ambient temperature
- 22 hours at 50°C (122°F) and 90% RH
- Remain in 50°C and 90% RH over weekends
- Weekends do not count into cycles

Performance via Stressed Lap Shear Testing
- Under sustained load of 2400 Newtons
- Cure adhesive using platen press or oven
- Prepare 4-5 specimens with structural epoxy/glass beads
- Run test until 45 cycles achieved OR until all specimens fail
- If specimens don’t all fail, measure retained strength vs. initial strength or record number of cycles at which test was stopped
Alcoa 951 demonstrates superior and consistent performance

**Consistent and marked improvement in long-term durability of adhesive joints demonstrated in all Alcoa & OEM testing (via Proving Ground Simulation Exposure)**
“No one is perfect, but a team can be . . .”

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<tr>
<th>Alcoa</th>
<th>Chemetall</th>
<th>Partnership</th>
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<tbody>
<tr>
<td>• Leading supplier of <strong>aluminum</strong> in the automotive industry</td>
<td>• Leading supplier of <strong>surface pretreatments</strong> in automotive industry</td>
<td>• Alcoa 951 Technology <strong>commercialized</strong> for use by all aluminum and automotive companies</td>
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<td>• Proven <strong>Alcoa 951 patented pre-treatment technology</strong></td>
<td>• <strong>Global outreach</strong> to customers for products and <strong>technical support</strong></td>
<td>• Enable <strong>greater use of aluminum</strong> throughout industry</td>
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<td>• Experience in <strong>joining</strong> and <strong>multi-material design</strong></td>
<td>• World class <strong>manufacturing facility</strong> in Jackson Township, MI</td>
<td>• Further <strong>lightweight vehicles</strong> through use of light, durable aluminum-intensive designs</td>
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![Alcoa Image](image1)

![Chemetall Image](image2)
Our Commitment & tenacity in meeting customer needs

Deriving Customer Insight

- Strong internal **business linkages**
- **Intimate connections with customers** to understand emerging needs

Establishing Credibility

- **Technical credibility, trust and partnership** with customers and suppliers
- **Continuity and commitment** to customer goals
- Partnership with respected global chemical company (**Chemetall**)

Understanding “Big Picture”

- **Refresh technology** in response to fluctuating market conditions
- **Leverage points of value generation:**
  - Enabling aluminum sales;
  - Alcoa pretreated product;
  - Revenue through licensing