Aluminum Superior in ...
Shedding Mass
Boosting MPG
Reducing CO$_2$

Global Automotive Lightweight Materials Conference
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Introduction

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Marketing Director, Alcoa Inc.
Outline

Market Overview

Study 1 | Mass reduction potential with aluminum in a Toyota Venza

Study 2 | CO$_2$ Life Cycle Assessment of Aluminum in Cars
Aluminum Use in Vehicles Accelerating

Source: Ducker Worldwide 2011
Aluminum Bodies on the Road

**Tesla Model S**
- World Car of the Year Award Winner
- Automobile Magazine’s Car of the Year
- 5 Star Safety Rated

**Range Rover**
- World’s First All-Aluminum SUV
- 39% lighter body

**Corvette Stingray**
- Aluminum Frame 100lbs lighter than prior
- 57% stiffer

Next Step...
Mass Market Car?
Supply Considerations

- Massive auto aluminum growth wave is about to hit in North America
- Ample primary metal supply
- Sheet, casting, and extrusion suppliers are ramping-up rapidly
- Early involvement of supply base is critical (3+ yrs ahead of SOP) to ensure infrastructure is in place
Objectives

1. Use same baseline Venza as used by EPA in their study of MODERATE weight reduction potential

2. Target an aluminum-intensive body

3. Retain: size, functionality, safety (5★), NVH, performance, etc.

4. Materials and processes available and practical by 2017

5. Highly respected 3rd party analysis

Source: ATG AIV
Result: Major Shift in Material Mix

Baseline Venza

- Steel: 59%
- Aluminum: 9%
- Mg: 0%
- Iron: 8%
- Plastics: 9%
- Glass: 3%
- All Other: 12%

Total Mass: 1,711 Kg

28% Mass Reduction

Venza AIV

- Steel: 30%
- Aluminum: 37%
- Mg: 4%
- Iron: 4%
- Plastics: 10%
- Glass: 3%
- All Other: 12%

Total Mass: 1,237 Kg

Source: ATG AIV
## Comparing to the Moderate case

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Multi-Material (MMV)</th>
<th>Aluminum (AIV)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Closure Material</strong></td>
<td>Steel</td>
<td>Aluminum</td>
<td>Aluminum</td>
</tr>
<tr>
<td><strong>BIW Material</strong></td>
<td>Steel</td>
<td>Steel</td>
<td>Aluminum</td>
</tr>
<tr>
<td><strong>Body &amp; Closure Mass Reduction</strong></td>
<td>-</td>
<td>(14%)</td>
<td>(39%)</td>
</tr>
<tr>
<td><strong>Total Vehicle * Mass Reduction</strong></td>
<td>-</td>
<td>(18%)</td>
<td>(28%)</td>
</tr>
<tr>
<td>**Cost Impact * **</td>
<td>-</td>
<td>(- $ 0.47 / Kg)</td>
<td>(+ $1.12 / Kg)</td>
</tr>
<tr>
<td>**Fuel Economy Impact * **</td>
<td>-</td>
<td>+3.1 MPG</td>
<td>+4.8 MPG</td>
</tr>
</tbody>
</table>

* Note: Full Vehicle Mass Optimization

Source: ATG AIV
Summary

Aluminum intensive mid-size cross-over SUV can meet all design objectives: size, functionality, safety, NVH, performance

28% (476 Kg) total mass reduction
— aluminum – BIW, closures, chassis, suspension, brakes

Estimated cost impact: +$534 ($0.51/Lb)

FE impact: +4.8 MPG fuel economy
(from 27 to 31.8 MPG)

Source: ATG AIV
Oak Ridge National Lab comparison of environmental performance of:

- **Baseline Toyota Venza (Current production)**
  1711kg

- **Moderately lightweighted Toyota Venza (LWSV)**
  1399kg

- **Aluminum-intensive (AIV) Toyota Venza**
  1236kg
Automotive Aluminum CO₂ Life Cycle Assessment
Vehicle Life Cycle Stages

Avoided Primary Metal Production Occurs at Manufacturing (prompt scrap) and End-of-Life (post-consumer scrap)
Life Cycle Energy Findings

- 94+% impact is in the use phase
- 32% better than baseline
- 17% better than LWSV

Note: Based on Baseline 1168 kg Components of a 1711 kg Curb Weight Vehicle
CO$_2$e Breakeven Analysis

Breakeven Distance:
- AIV:Baseline: ~ 3,000 km
- AIV:LWSV: ~ 34,000 km

CO$_2$ eq. (Kg) vs. Vehicle Driven ('000 KM)
### Summary

<table>
<thead>
<tr>
<th>Fact</th>
<th>Metric</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>Shift to aluminum is accelerating</td>
<td>10X by 2025</td>
<td>Ducker</td>
</tr>
<tr>
<td>Aluminum saves more weight than steel can</td>
<td>28% vs. 18%</td>
<td>EDAG</td>
</tr>
<tr>
<td>Aluminum is cost effective</td>
<td>$.51 / lb saved</td>
<td>EDAG</td>
</tr>
<tr>
<td>Lower lifecycle energy</td>
<td>32% Lower</td>
<td>ORNL</td>
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Questions?

Thank You!

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