NEW FUEL EFFICIENCY STANDARDS PROVIDE LARGE-VOLUME TITANIUM OPPORTUNITIES

Kurt Faller
www.TiSolutionsConsulting.com
Auto Industry Factors of 2009

Confluence of factors presents a clear large-volume opportunity for the titanium industry.

- Fuel Price Sensitivity
- Demand for Large Vehicles
- New Emissions Regulations
- Auto Industry Ti Knowledge
- Excess Ti Industry Capacity
A Review of the Major Applications

- 700 million wheel rim screws
- 35 million engine valves
- 1.7 million exhaust systems
- 1 million connecting rods
- 450,000 turbocharger compressor wheels
- 200,000 suspension springs

A 3000 tonne/year market
Fuel Prices are Changing Behaviors

- Despite fuel prices now 39% lower than 2008, they remain 2X the average price of 1990 - 2004.
- Fuel efficiency has started to influence purchases.

Large Vehicle Demand and Conflicting Emissions Requirements

Light truck sales YTD 2009 are down, but still account for 43% of US sales (pick-up, SUV, van, minivan)

- Of top three best selling vehicles of 2009, two are trucks:
  1. 262,000 Ford F Series
  2. 239,000 Toyota Camry
  3. 209,000 Chevrolet Silverado

Americans are addicted to large vehicles.

We simply want more fuel efficient large vehicles.

<table>
<thead>
<tr>
<th>Regulator, and Control</th>
<th>Phase-in Period</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA Tier 1: CO, NO_x, PM</td>
<td>1994-1997</td>
<td>Vehicle weight dependant max limits for &lt;8500 GVWR</td>
</tr>
<tr>
<td>EPA Tier 2: CO, NO_x, PM</td>
<td>2004-2009</td>
<td>&quot;bins&quot; ranked cleanest to dirtiest 1-11, 1-10 for &lt;8500 GVWR. Fleet must meet bin average target, which gets more strict each year.</td>
</tr>
<tr>
<td>NHTSA: CAFE, (CO_2)</td>
<td>1973-1985</td>
<td>Ramp from 18 - 27.5 MPG for car fleet fuel economy for vehicles &lt; 8500 GVWR; in 2004 light trucks 20.7 MPG</td>
</tr>
<tr>
<td>NHTSA CAFE, (CO_2)</td>
<td>2007</td>
<td>No longer exempt SUV and Vans &lt;10,000 GVWR; Pick-ups &lt;8500 GVWR must comply</td>
</tr>
<tr>
<td>NHTSA: CAFE, (CO_2)</td>
<td>2011</td>
<td>30.2 MPG Total Sales rated harmonic mean, with 23.5 MPG required for trucks</td>
</tr>
<tr>
<td>NHTSA EISA 2007: CAFE, CO_2</td>
<td>2020</td>
<td>Car and light truck combined fleet average to 35 MPG, however, 9th Circuit Court of Appeals revoked because not sufficiently strict</td>
</tr>
<tr>
<td>Obama May 19, 2009: NHTSA, EPA and CARB; CO, CO_2, NO_x, PM</td>
<td>2010-2016</td>
<td>Fleet average for cars = 39 MPG and trucks = 30 MPG by 2016, variable by truck footprint</td>
</tr>
</tbody>
</table>
Per AEO2009 (NHTSA/Obama): A Given Size Vehicle Must Meet Stricter Fuel Economy Requirements

New Light Truck Fuel Economy Requirements

Footprint

MPG

MY 2011
MY 2012
MY 2013
MY 2014
MY 2015
Auto Industry Solutions?

- **Smaller vehicles**
  - Consumer demand?
  - No help with compliance

- **Hybrid technologies**
  - Long lead, $$$ R&D, and industry is broke

- **Turbo-charging**
  - High EGR requires Ti compressor wheels

- **Light-weighting**
  - Ti springs and exhaust each offer 15 – 40 kg weight savings

- GM: 200 lb. mass fleet reduction = 2.5% CAFE improvement = 0.7 MPG

- Chrysler: 100 lb. = 1 MPG city
### Weak Auto Industry Financials Makes Titanium More Compelling

**Weight Reduction Options**

Comparing 20,000 Vehicle Production

<table>
<thead>
<tr>
<th></th>
<th>Aluminum Hood</th>
<th>Ti Springs (4)</th>
<th>Ti Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight savings per car (kg)</td>
<td>12</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>Tooling Charge</td>
<td>$10,000,000</td>
<td>$20,000</td>
<td>$200,000</td>
</tr>
<tr>
<td>Tooling charge/car</td>
<td>$500.00</td>
<td>$0.25</td>
<td>$10.00</td>
</tr>
<tr>
<td>Material premium over steel ($/car)</td>
<td>$20</td>
<td>$800</td>
<td>$400</td>
</tr>
<tr>
<td>Labor premium over steel ($/car)</td>
<td>$10</td>
<td>$40</td>
<td>$50</td>
</tr>
<tr>
<td>$/car</td>
<td>$530</td>
<td>$840</td>
<td>$460</td>
</tr>
<tr>
<td>$/kg saved</td>
<td>$44.17</td>
<td>$32.32</td>
<td>$16.43</td>
</tr>
</tbody>
</table>

- Ti components provide light-weighting with current technology and low tooling costs
- Smaller volumes per platform further enhance Ti opportunity
Ti Knowledge is “On the Shelf”

Initial use in smaller volume premium cars was to obtain Ti experience.

Production knowledge exists for component manufacturers and Ti supply chain.

Auto industry main concerns are Ti industry’s ability to provide high-volume, and on-time delivery.
Today, the Ti Industry *is Able* to Meet Auto Industry Demand

**Real and Hypothetical Examples**

- Corvette ZO6 connecting rod = 100 metric tons
- Cummins diesel compressor wheel = 300 metric tons
- Chrysler minivan exhaust = 2,500 metric tons
- Ford Explorer exhaust = 4,000 metric tons

- Mill products are best supported with non-aerospace processing:
  1. Low-cost alloys containing iron
     - Off-grade sponge
  2. Single hearth melting
  3. Steel-mill conversion

- Due to recent expansions, all three are unconstrained