Lightweight Materials

Carol Schutte
Materials Technology Team Lead
Vehicle Technologies Program
US Department of Energy
Washington, DC

Materials R&D Team

<table>
<thead>
<tr>
<th>J. Gibbs</th>
<th>W. Joost</th>
<th>J. Eberhardt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Propulsion Materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lightweighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HTML</td>
</tr>
</tbody>
</table>
What are the top 5 future Service/Agency needs (in 20 to 25 years)?

**Key Administration Goals Relevant to Vehicle Technologies**
- Reduce greenhouse gas emissions by 50% in 2030 (from 2005 baseline) and by 80% in 2050

**What does this really mean?**
- In 2050 we need 50mpg vehicles with 45% miles electrified
- If we only achieve 45mpg with 0% electrified miles then reduce the total number of miles traveled by 70%
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles

**Goal:** Develop high performance cost-effective materials that enable high efficiency propulsion systems that reduce energy consumption by focusing on key technical deficiencies in materials performance that limit expanded capabilities of advanced combustion engines, electric-drive systems, and utilization of renewable fuels

**Goal:** Provide state of the art characterization facility to provide enabling and unique materials characterization that supports materials challenges relevant to the Vehicles Technologies Program

---

**Materials**

- **Lightweighting Materials**
- **Propulsion Materials**
- **High Temperature Materials Lab**
## Materials Budget History

<table>
<thead>
<tr>
<th>Budget area</th>
<th>FY’10 $K</th>
<th>FY’11 $K (CR)</th>
<th>FY’12 $K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweighting Materials</td>
<td>30,652</td>
<td>29,619</td>
<td>26,244</td>
</tr>
<tr>
<td>Propulsion Materials</td>
<td>12,989</td>
<td>12,962</td>
<td>9,720</td>
</tr>
<tr>
<td>HTML</td>
<td>5,662</td>
<td>5,650</td>
<td>972</td>
</tr>
<tr>
<td>SBIR/STTR</td>
<td>0*</td>
<td>1,389</td>
<td>1,064</td>
</tr>
<tr>
<td>Total</td>
<td>49,303*</td>
<td>49,620</td>
<td>38,000</td>
</tr>
</tbody>
</table>

* SBIR/STTR transferred in FY2010 was $1,268 for SBIR and $152,169 for STTR
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.

**Automotive Metals**
Reduce vehicle weight by advancing the properties, cost, multi-material processing, and modeling/simulation of advanced metals.

**Multi-material Enabling**
Advance joining, corrosion prevention, non-destructive evaluation...

**Properties and Manufacturing**
- Enable development of non rare earth alloyed Magnesium with energy absorption comparable to Aluminum
- Advance understanding of 3rd Generation AHHS high strength/ductility

**Modeling and Computational Materials Science**
- Enable improved ductility in Mg castings by understanding current limitations

**USAMP**

**BAA**

**ORNL**

**PNNL**

**NSF**
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.
Lightweighting: Carbon Fiber

By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.

Low Cost Carbon Fiber Production
ORNL

Goal: Lower weight potential of vehicle by reducing the cost of carbon fiber to ~$5/lb.

Low Cost Precursors
Carbon Fiber from Polyolefins (higher performance intermediate to long term term)
Complete initial evaluation of PAN-MA produced in a textile facility for higher strength, lower cost applications. (short term)
Minimum target properties are 400 KSI strength and 30 MSI modulus

Speed Up and Increase Capacity for Oxidation
Advanced Oxidation of CF Precursors
Demonstrate the ability to oxidize multiple large tows in ~1/2 of conventional residence time

Speed Up Conversion
Define the MAP operational capabilities and limitations necessary to scale up

Conventional Interfacial Optimization
Ensure that fiber matrix adhesion is sufficient to validate low cost carbon fiber in composites for future demonstration projects
By 2015, validate (to within 10% uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50% with recyclability comparable to 2002 vehicles.

Lower weight potential of vehicles by developing enabling tools by:
- Lowering manufacturing cost through enabling tools
- Speeding up product development cycle time

Predictive Modeling: validate fiber length and distribution and predicted mechanical properties within 10% for samples made from mold of intermediate complexity.

Composite Underbody Attachment
www.vehicles.energy.gov

Carol Schutte, PhD
Team Lead for Materials Technology
Vehicle Technologies Program
Email: carol.schutte@ee.doe.gov