Vehicles Technology Program Annual Merit Review – Lightweight Materials

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Materials Technologies

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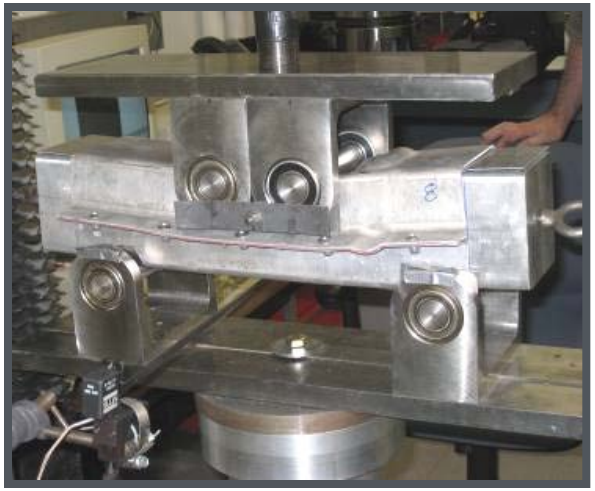
Goals for Materials

Lightweighting improves efficiency of all vehicles:
Reduce the weight of the vehicle by 50% in a cost effective way

- Vehicle lightweighting: 6-8% improvement in fuel economy with every 10% weight savings
- Secondary compounded benefits: reducing the power requirement for the motor or engine

Propulsion materials support the goal of achieving combustion efficiency:
Passenger vehicles up to 45% and commercial vehicles 55% at today's cost :

- Requirements are demanding
  - High pressure fuel injection materials up to 45,000 psi for diesel engines
  - Peak cylinder pressure > 2,700 psi



Candidate Lightweighting Alternative Materials

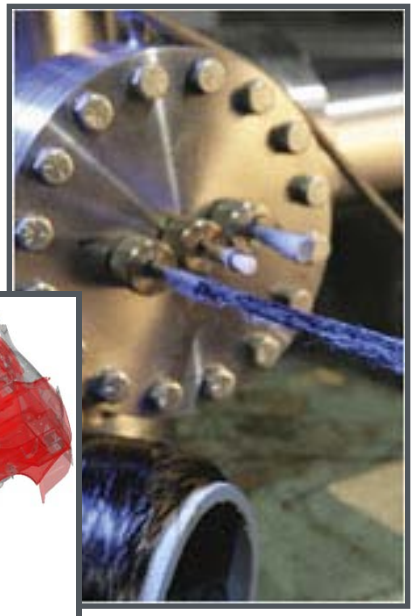
How to lower the cost of materials with significant contribution to weight savings?
Which material shall we use where?
How do we use these lightweight materials safely?

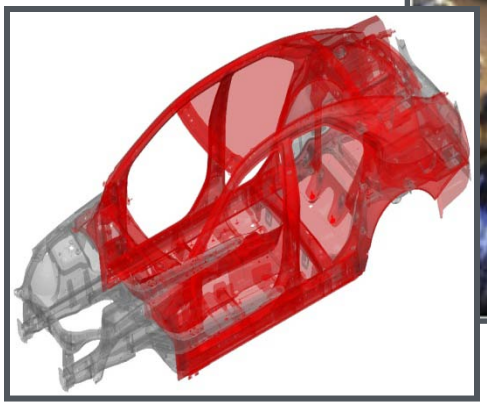
Lightweight Material	Material Replaced	Mass Reduction (%)
Magnesium	Steel, Cast Iron	60 - 75
Carbon Fiber Composites	Steel	50 - 60
Aluminum Matrix Composites	Steel , Cast Iron	40 - 60
Aluminum	Steel, Cast Iron	40 - 60
Titanium	Alloy Steel	40 - 55
Glass Fiber Composites	Steel	25 - 35
Advanced High Strength Steel	Mild Steel, Carbon Steel	15 - 25
High Strength Steel	Mild Steel	10 - 15

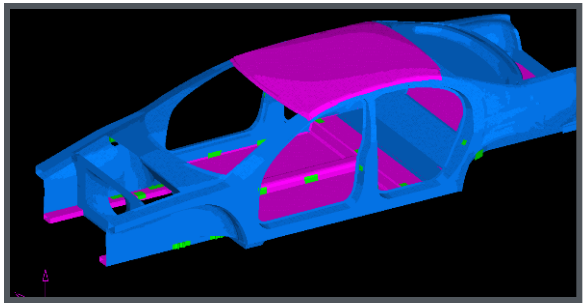
Program Staff - Office of Transportation Technologies, Energy Efficiency and Renewable Energy, Office of Advanced Automotive Technologies R&D Plan - Energy Efficient Vehicles for a Cleaner Environment, DOE/ORO/2065, March (1998) pp. 75 - 88.

Cost Modeling Provides Guidance

- Estimates the cost-effectiveness on a life cycle basis
- Evaluates process economics, energy, and environmental viability from a life cycle perspective
- Estimates manufacturing costs
- Which material shall we use where?
- What weight savings can we achieve?
- Primary and secondary
- How much will it cost?
- Compares different manufacturing processes
- Analyzes the impact of barriers and benefits of different options for overcoming the barriers



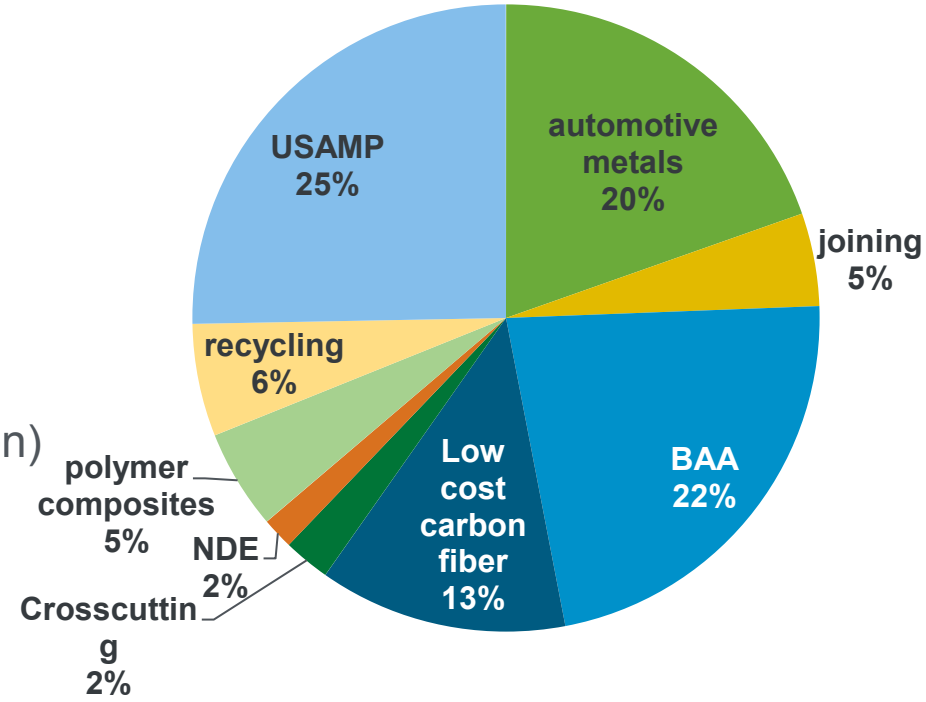




Lightweighting Portfolio

Demonstration projects provide validation and address safety:

- Magnesium Front End
- Multi-Material Vehicle
- Steel frame
- Composite Floor and seats



Processing studies

- Lower cost (carbon fiber, domestic production)
- Lower risk (predictive engineering)

Fundamental and applied studies
Fill the "toolbox"

- Integrated Computational Materials Engineering (ICME)
- NSF 3rd Generation Advanced High Strength Steels
- Models for predicting crash energy management (polymer composites)

www.vehicles.energy.gov

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