Materials

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Materials Technology Budget by Activities

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

	FY'10 $K	FY'11 $K	FY'12 $K
Major Activity	Appropriation	CR value	Request
Materials Technology	49,303*	49,620	38,000
Lightweighting Materials	30,652	29,619	26,244
Propulsion Materials	12,989	12,962	9,720
HTML	5,662	5,650	972
SBIR/STTR	0*	1,389	1,064

* SBIR/STTR transferred in FY2010 was $1,268 for SBIR and $152,169 for STTR

Materials Technology Goals FY 2011

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Materials Technology
$49,620K

Lightweighting Materials
$29,619K

Propulsion Materials
$12,962K

High Temperature Materials Laboratory
$5,650K

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

Develop high performance cost-effective materials to address key technical materials deficiencies limiting the performance of propulsion systems

Provide state-of-the-art materials characterization facility to resolve materials-related barriers impeding the success of VTP research

Lightweighting Materials Structure and Benefits

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

Lightweighting Materials $29,619K

- **Enabling**
- **Metals**
- **Polymer Composites**

Vehicle class (weight reduction target)	Fuel Efficiency improvement % (per vehicle)	Reduced Fuel Use % (per vehicle)	GHG reduction % (per vehicle)
Cars (30%)	**21**	**17**	**17**
Cars (50%)	**35**	**26**	**26**

Benefits assume that for each increment of 10% weight reduction a benefit of 7% efficiency is realized. (1.)

1. Duleep, K. G. "Analysis of Light Duty Vehicle Weight Reduction Potential" July 2007 p. 1-3

Data and analyses provided by P. Patterson VTP, DOE

Lightweighting Materials

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

BAA/Solicitation (NETL)

- Multimaterial vehicle (50% lighter)
- Low-cost carbon fiber
- Low-cost Magnesium production
- Magnesium-intensive front end
- Validate crash models for composites via demonstration

Reduce vehicle weight by 50%

Design, build, and validate a 50% lighter prototype vehicle compared to a 2002 vehicle

Results of validation lead to:

- Early commercialization of technical success
- Identification of technical gaps to lightweighting that still need to be addressed

Weight Reduction Potential of Materials

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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.

Lightweighting: Vehicle Safety

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- ❑ **Statistical analysis of vehicle lightweighting –**DOE/LBNL Tom Wenzel
  Estimate the safety impacts of contemporary vehicle weight changes while holding vehicle footprint and other variables constant
  - Vehicle size and weight safety analysis
  - Results will support CAFE and GHG emissions standards for 2017-2025
  - With NHTSA, establish a common publicly available database

❑ **Validate crash model(s) for carbon fiber composites**
(solicitation topic)

❑ **Validate crash/deformation models for Mg and Mg joints**
(Magnesium front end project)

Lightweighting: Examples of key activities

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Material	Challenges	Goal	Activity
Enabling: Safety	Understand lightweighting and safety	Understand key variables controlling safety	Analyze crash data for vehicles 2000-2007 models
Automotive Metals: Properties and Manufacturing	Mg performance limited rare earth supply	Energy absorption comparable to Al	Non-rare earth alloyed magnesium
Automotive Metals: modeling and computation	Steels with high strength exhibit low ductility	Simulated steel microstructure -1200 MPa tensile strength and 25% elongation	Improve and validate microstructural models of multi-phase steels
Automotive Metals: Multi-material enabling	Joining dissimilar metals	Joint efficiency of greater than 60% for Mg-x joints	Improve understanding friction-stir and ultrasonic Mg-x joints
Polymer composites: carbon fiber	Cost	$5/lb for carbon fiber	new precursors, speed up oxidation, speed up conversion
Polymer composites: predictive engineering Injection molding	Can’t predict performance	Predict fiber length and orientation	Validate current model for shape intermediate complexity

Carbon Fiber Technology Center (CFTF) $34.7M (ARRA)

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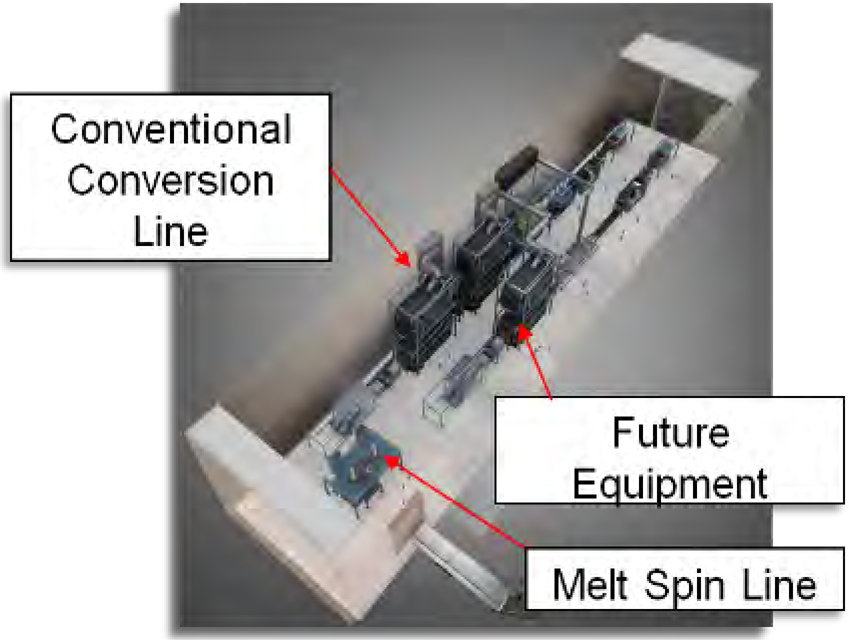
- Highly instrumented, highly flexible conventional carbon fiber line for “any precursor in any format”
- Melt-spun fiber line to produce precursor fibers
- Provisions for additional future equipment
- Produce up to 25 tonnes/year of carbon fibers
- Demonstrate technology scalability
- Train and educate workers
- Grow partnerships with US industry



Facility and equipment perspective

Lightweighting: Significant Accomplishments

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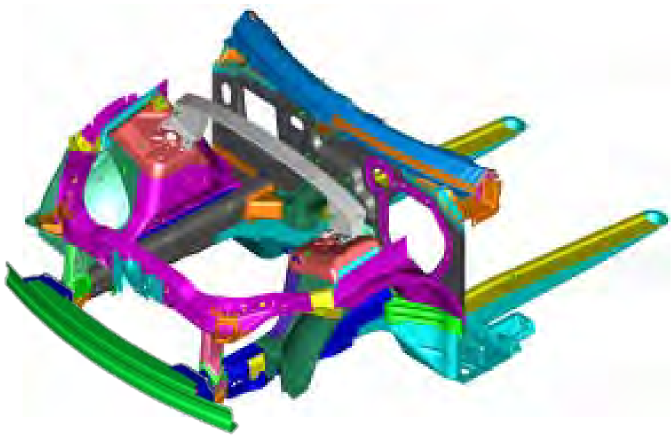
Low cost carbon fiber

Current carbonized textile properties	Goal	Measured
Strength (KSI)	250	540
Modulus (MSI)	25	38
Cost estimate ($/lb) at high volume	$5.00	$5.74

Metals: Mg intensive front end

Platform	Weight Savings kg (%)	Part Count Reduction
Cadillac CTS (unibody)	44.3kg (44.5%)	57.3%
F150 (body-on-frame)	14.9kg (24.9%)	10%



Propulsion Materials

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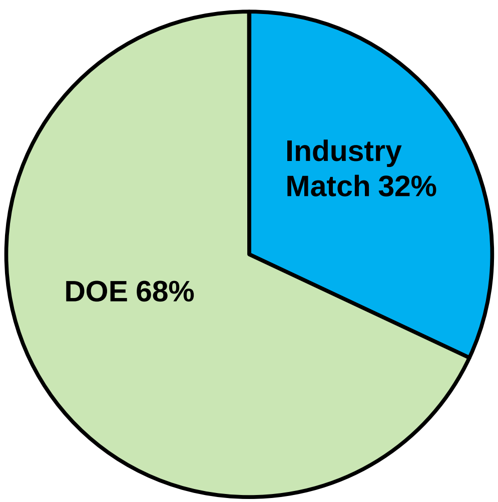
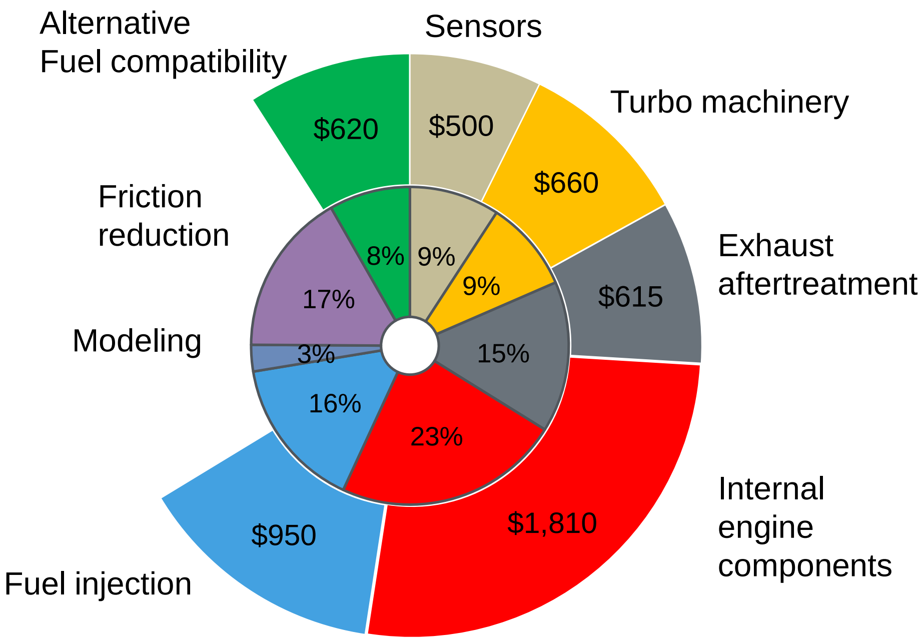
Goal: Develop high performance cost-effective materials to address key technical materials deficiencies limiting the performance of advanced combustion engines, electric-drive systems, and use of renewable fuels

Propulsion Materials
$12,962K

- **Materials for Hybrid and Electric Drive Components**
- **SuperTruck (NETL)**
- **Materials for Internal Combustion Engines**

In-kind Match for Lab Projects





Propulsion materials: Examples of key activities

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Material	Challenges	Goal	Activity
HEV applications: Hybrid and electric drive materials	Rare earth element supply limited	Understand how to develop non-rare earth magnets	Using computational modeling, evaluate potential non-rare earth magnetic materials
Materials for Internal Combustion Engines: Materials for Exhaust and Energy Recovery	Valves and Turbochargers must maintain strength at high temperatures: Thermoelectrics increased efficiencies	By 2015, enable 15% efficiency improvement (40-55%) on emissions compliant HD engines capable of operating on bio-fuels.	Understand and mitigate performance issues for energy recovery systems: new fuel formulations and engine materials
Materials for Internal Combustion Engines: Application specific materials development	Develop coolants with increased thermal capacity and good flow characteristics	Improve cooling system performance for ICEs and reduce need for secondary cooling in Hybrid Electric Vehicles	Complete initial evaluation of nano-fluid based coolants for improving the ICE efficiency
Materials for Internal Combustion Engines (ICEs): High efficiency engines	Materials strength and cost currently limits production ICE efficiency relative to theoretical limits	By 2020, develop cost effective materials to enable ICEs with 60% efficiencies.	Develop advanced materials for Engine Block and Key Combustion Chamber Components

High Temperature Materials Laboratory (HTML)

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Goal: Provide state-of-the-art materials characterization facility to resolve materials-related barriers impeding the success of VTP research

HTML (ORNL)
$5,650K

Expand materials characterization capabilities for:

- Measurements of microstructures in air
- Warm material temperature measurements
  - -understand effect of temperature gradients on joints, welds, and other applications.

Support User Center vehicle materials-related projects

[69 active projects in FY 2010]

Contact Information

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