New Approaches to Manufacturing Innovation in DOE

June 5, 2013
Energy

• U.S. Big Picture
• EERE and the Advanced Manufacturing Office Overview
• AMO Partnership Approach
  • R&D projects
  • R&D Infrastructure
  • Technical assistance
  • Interagency coordination
What is Advanced Manufacturing?

A family of activities that:

• Depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or

• Make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences (e.g. nanotechnology, chemistry, and biology)

Advanced Manufacturing involves both:

• new ways to make existing products

• making new products based on advanced technologies.
U.S. Trade Balance of Advanced Technology

- 11% of U.S. GDP
- 12 million U.S. jobs
- 60% of U.S. engineering and science jobs
- 57% of U.S. Exports
- Nearly 20% of the world’s manufactured value added

Source: Census Bureau
Clean Energy: A Top Administration Priority

Part of All-the-above Strategy

Security
- Energy self-reliance
- Stable, diverse energy supply

Environment
- Clean air
- Climate change
- Health

Economy
- Competitiveness
- Competitiveness in clean energy
- Domestic jobs

Clean Energy Solutions
Office of Energy Efficiency and Renewable Energy (EERE)

Collaboration toward:
Common goal to collectively increase U.S. manufacturing competitiveness

Coordination for:
• Reduction of duplication
• Translation of best practices
• Codifying universal models
AMO co-invests with private and public partners to:

• Improve U.S. competitiveness
• Save energy
• Create and retain high-quality domestic manufacturing jobs
• Ensure global leadership in advanced manufacturing.

Program Focus

• Research and Development Projects - bring the next generation manufacturing technologies and materials to full scale industrial use.

• Advanced Manufacturing R&D Facilities - engage in developing a rigorous set of industrial process technologies and materials that can be applied across a spectrum of globally competitive U.S. manufacturers and suppliers.

• Industrial Technical Assistance - drive a corporate culture of continuous improvement in corporate energy management and wide scale adoption of technologies, such as combined heat and power, to reduce energy use in the industrial sector.
AMO Aims for Economy-Wide Lifecycle Impacts

MAKE

Products for efficient manufacturing

Industrial 31%

USE

Transportation 28%

Residential 23%

Commercial 18%

Products for efficient use
AMO R&D Focus: Bridging the Gap

AMO Investments leverage strong Federal support of basic research by partnering with the private sector to accelerate commercialization.

Technology Maturity (TRL; MRL; etc.)

- Concept → Proof of Concept → Lab scale development → Demonstration and scale-up → Product Commercialization

Governments and Universities

- DOE Energy Innovation Hubs
- NSF Engineering Research Centers
- NSF IUCR Centers
- SBIR/STTR

Private sector

- AMO Focus facilities
- NIST Manufacturing Extension Partnership

Gap

"Valley of Death"
Advanced Manufacturing Office Goals

• **R&D**
  – Reduce the life-cycle energy consumption of manufactured goods by 50 percent over 10 years for AMO supported technologies
  – Assist EERE to manufacture clean energy technologies

• **Technical Assistance**
  – Encourage a culture of continuous improvement in corporate energy management
  – Support achievement of 40 GW of new combined heat and power (CHP) by 2020
AMO co-invests with industry in cross cutting foundational technologies that **benefit many industries** and markets, including the most energy-intensive manufacturing sectors.

A foundational technology can be a product, a material, or a process, that is likely to provide **high impact** energy, environmental, and economic benefits for manufacturing.
Shared R&D Infrastructure

Supporting an “industrial commons” including shared R&D Facilities:

- Buy down the risk profile for innovators, SMEs
- Connect energy intensive sectors with SME innovations
- Focus a sector, or set of sectors around common technical challenges and build partnerships
- Address workforce challenges
- Fund critical space along the technology development lifecycle (“the missing middle”)
Advanced Manufacturing Office (AMO)

**Additive Manufacturing**

- Arcam electron beam processing AM equipment
- POM laser processing AM equipment

Program goal is to accelerate the manufacturing capability of a multitude of AM technologies utilizing various materials from metals to polymers to composites.

**Carbon Fiber**

Exit end of Microwave Assisted Plasma (MAP) process, jointly developed by ORNL and Dow

Program goal is to reduce the cost of carbon fiber composites by improved manufacturing techniques such as MAP, which if scaled successfully could reduce carbonization cost by about half compared to conventional methodology.

Oak Ridge National Laboratory Manufacturing Demonstration Facility

Supercomputing Capabilities

Spallation Neutron Source
## Current Manufacturing Portfolio (FY11 – Present)

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Material Type</th>
<th>Program/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale-up of Novel Low-Cost Carbon Fibers Leading to High-Volume Commercial Launch (ongoing)</td>
<td>PO</td>
<td>Dow/Ford/ORNL, IMI Portfolio: Scale-up of PO sulfonation/desulfonation stabilization and CF production to 4 kg/hr at Dow and ORNL CFTF</td>
</tr>
<tr>
<td>Staff and Procedure Development for Carbon Fiber Test Facility (ongoing)</td>
<td>Various</td>
<td>ORNL MDF: Operations Support and Technical Collaborations</td>
</tr>
<tr>
<td>Commercialization of New Carbon Fiber Materials Based on Sustainable Resources for Energy Applications (completed)</td>
<td>Lignin</td>
<td>ORNL/GrafTech, Materials ARRA Portfolio: Production of graphite matte for application in industrial insulation applications and evaluation of other industrial applications</td>
</tr>
<tr>
<td>Induction Consolidation Molding of Thermoplastic Composites Using Smart Susceptors (completed)</td>
<td>CF and Glass Fiber Reinforced Composites</td>
<td>Boeing, Ford, Vestas, Energy Intensive Process Portfolio: Out-of-autoclave consolidation molding of fiber reinforced composites</td>
</tr>
</tbody>
</table>
Problem: Carbon Fiber Cost Tied to Petroleum Volatility

PAN is based on petroleum precursor…

- Carbon fiber manufacturing is heavily dependent on cost of oil (> 50% carbon fiber cost the cost of PAN)
- Oil price volatility is correlated to the cost of PAN precursor, acrylonitrile

### CF Manufacturing Cost Breakdown

- 51% precursor
- 18% labor
- 12% depreciation
- 10% utilities
- 9% other


### Linkage Between Crude Volatility and Acrylonitrile Cost

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Crude Oil ($/Bbl)</th>
<th>Acrylonitrile ($/MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/2010</td>
<td>$81/Bbl</td>
<td>$1,950/MT</td>
</tr>
<tr>
<td>05/2011</td>
<td>$101/Bbl</td>
<td>$2,820/MT</td>
</tr>
<tr>
<td>10/2011</td>
<td>$86/Bbl</td>
<td>$1,940/MT</td>
</tr>
</tbody>
</table>

Sources:
1. EIA Spot Price for WTI
2. Fibers2fashion.com
Thank you!

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