9913 Development of Steel Foam Materials and Structures

Benefits

- Construction of lighter-weight transportation systems (automobiles, trucks, ships, railcars), that will reduce fossil fuel consumption and environmental pollution
- Production of safer vehicles due to crash energy absorption capabilities of metal foams
- Reduced energy consumption in primary steel processing from the use of recycled steel scrap and steel foam to produce steel foam
- Enhanced protection of military vehicles and personnel against ballistic mine, and high-energy blast threats
- Recyclability of steel scrap and steel foam significantly reduces the need for landfills

Applications

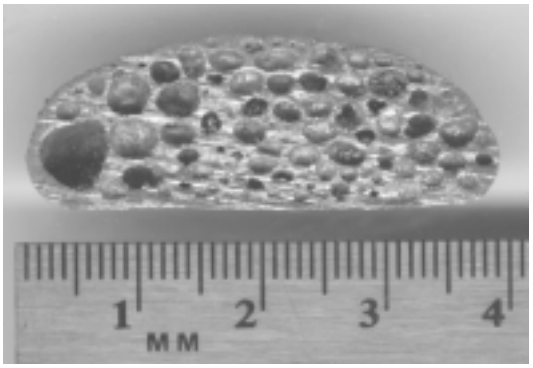
Successful completion of this project will provide the materials and process technology required for successful application of the technology in industry.

Construction of lighter-weight transportation systems will result in improved fuel efficiency, increased recyclability, and reduced environmental pollution

Metal foams with high levels of controlled porosity are an emerging class of ultra-lightweight materials that are receiving increased attention for a broad range of applications. Manufacturers are seriously considering the use of metal foams as a result of demands for weight reduction, improved fuel efficiency, and increased passenger safety in transportation systems. The efficient energy-absorption characteristics of steel foams can provide safer commercial and military vehicles through design of improved crash-energy management components. Lightweight steel foams can improve operational efficiency and competitiveness in shipbuilding and passenger and freight rail systems. Additional benefits of using metal foams are the ability to produce metal foams from recycled metal scrap and the ability to recycle foam scrap.

The Fraunhofer Institute for Applied Materials Research (IFAM) in Bremen, Germany, has developed and patented a process for producing metal foam materials and structures. This technology is receiving increased interest for producing steel foams. The powder metallurgy foam metal process is being developed further by the Fraunhofer USA Center - Delaware (FC-DE), in Newark, Delaware, which is a part of Fraunhofer USA, a wholly owned subsidiary of Fraunhofer-Gesellschaft.

The American Iron and Steel Institute (AISI) Technology Roadmap Program (TRP), in conjunction with the U.S. Department of Energy (DOE), is conducting a three-year project that entails designing, fabricating, and testing prototypes to demonstrate the advantages of steel foam materials and structures at the FC-DE. The project's tasks focuses on (1) steel foam materials and process development, (2) materials property measurements, and (3) fabrication and evaluation of generic steel foam shapes. Completion of these tasks will provide the materials and process technology base required for successful demonstration, manufacturing, and commercialization of steel foam materials in the U.S.



Microstructure of porous steel foam.

Project Description
Goal: To advance the development, characterization, and use of steel foam materials by demonstrating the unique advantages of novel light-weight materials.

Candidate applications, materials property and performance requirements, and generic foam shapes will be identified early in the program. These functional performance and materials property requirements will be used to guide the optimization of steel foam chemical composition, level of porosity, and foam component design. Steel foam materials properties will be determined as a function of composition, volume percentage of porosity, and processing/heat treating conditions. Several generic steel foam geometries will be evaluated: (1) complex three-dimensional steel foam parts molded to net shape in die cavities, (2) steel foam sandwich panels comprising of steel foam core with steel face sheets, and (3) steel foam inside hollow steel profiles. Candidate applications will be identified for each of these three generic steel foam geometries. The steel foam materials and process technologies developed on this project will be available for manufacturing and commercialization.

Progress and Milestones
This three-year project has a start date of March 2000 and an end date of March 2003. The following plan for research is listed in chronological order:

- Year 1: Steel Foam Materials and Process Development
  - Evaluate Steel Powders and Foaming Agents.
  - Evaluate and Identify Powder Consolidation Processes.
  - Optimize Foaming Process Parameters.
- Year 2: Foam Characterization and Property Measurements
  - Evaluate Microstructural Characterization.
  - Determine Physical and Mechanical Property Measurements.
  - Test Corrosion Resistance.
  - Analyze and Compile Results into a Steel Foam Materials Database.
- Year 3: Steel Foam Generic Shape Fabrication and Testing
  - Identify Candidate Designs of Generic Steel Foam Shapes.
  - Coordinate the Prototypes for Fabrication of Steel Foam Shapes.
  - Identify and Demonstrate Joining and Assembly Methods.
  - Utilize Appropriate NDE Inspection Methods.
  - Test Steel Foam Shapes.
  - Develop Final Report.

Total Project Cost/Duration
$750,000/three years.

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Fraunhofer USA, Center for Manufacturing and Advanced Materials Delaware
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