LIGHTWEIGHT INNOVATIONS

Technology Project Abstract:

Powder 3 - Development of Cost-Effective, Advanced Mechanical Alloying, Powder Consolidation Processes for Sub-Micron Reinforced AL MMCs

Lead Industry Partner: Materion

Lead Research Partner: Case Western Reserve University

Technology Pillar: Powder Processing

Project Summary

This project addresses the cost of Al-SiC metal-matrix composites (MMCs) derived from novel mechanically-alloyed powders. Considerations include process optimization, technical cost modeling and assessment of novel consolidation methods believed to be lower in cost than the baseline hot isostatic pressing (HIP) method, but yielding similar strength-to-weight benefits and superior specific stiffness of the composite compared to wrought aluminum comparator.

Technology Gap / Need

The applications of Al-based, sub-micron SiC-reinforced MMCs have been limited due mainly to the relatively high cost of the current hot-isostatic pressing (HIP) consolidation process. The development of these MMCs also includes powder synthesis, mechanical alloying, consolidation, and post-heat treatment - all of which add to the cost structure of finished components. Novel processes are required that could eliminate, or greatly reduce, these processing steps, enabling greater cost competitiveness and enhance the capability for high-volume production and subsequent expanded potential for weight reduction in transportation applications.

Proposed Technology

Alternative consolidation processes for mechanically-alloyed Al-SiC MMCs have shown the potential to reduce overall manufacturing costs by both minimizing time at temperature as well as introduction of concomitant mechanical deformation steps, leading to improved mechanical properties. Approaches include alternatives to HIP for consolidation of billets prior to extrusion (e.g. selective plasma sintering), as well as direct powder extrusion or forging of net shapes. Processes that can eliminate the canning and de-canning steps of HIP are particularly attractive.

Project Benefits

A complete understanding of cost structure, property prediction tools and alternative processing routes will allow materials developers to reduce time and costs to deliver aluminum-based MMCs for use in future transportation platforms. The team is exploring two immediate applications of Al-SiC MMCs where improved performance and greater weight-reduction opportunities are assessed relative to baseline aluminum alloy extrusions and alternative powder-metallurgy compacts.

Education & Workforce Impact

A training program for professionals and technical staff to capture innovation in powder synthesis, advanced consolidation manufacturing technologies and ICME will be initiated with local community colleges and geared towards providing a unique skill set for powder processing technologies.

Project Duration

Start: June 2016
End: June 2018

Funding

Total Project Value: $3.12M

Participants

Industry Partners

Materion
Lockheed Martin
Boeing
GKN

Research Partners

University of Tennessee - Knoxville
Case Western Reserve University
Penn State University
Massachusetts Institute of Technology