

Analysis of the Potential for New Automotive Uses of Magnesium

Frank Stodolsky, Linda Gaines, Roy Cuenca, and Steve Wu
Argonne National Laboratory

The submitted manuscript has been authored by a contractor of the U. S. Government under contract No. W-31-109-ENG-38. Accordingly, the U. S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U. S. Government purposes.

59
DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This paper describes the scope of a new project, just initiated, for the Lightweight Materials Program within the Office of Transportation Materials. The Center for Transportation Research and the Energy Technology Division at Argonne National Laboratory will assess the feasibility and technical potential of using magnesium and its alloys in place of steel or aluminum for automotive structural and sheet applications in order to enable more energy-efficient, lightweight passenger vehicles. The analysis will provide an information base to help guide magnesium research and development in the most promising directions.

Vehicle weight reduction is one of the major means available for improving fuel efficiency and thereby enabling a reduction in the United States' dependence on petroleum imports. While high-strength steels, aluminum, and polymers are being used to achieve significant weight reductions in the current generation of automobiles produced in Detroit, magnesium and its alloys have been used until now in relatively small quantities, limited to die castings. Substantial weight reductions may be possible if improved magnesium alloys and forming processes are developed to enable the cost-effective use of magnesium and its alloys in sheet and/or structural forms. Magnesium alloy sheet could be used in vehicle semi-structural and structural applications, while extrusions could be used in structural applications. Currently, magnesium alloy sheet has found limited use in the aerospace industry, but the costs are too high for automotive use. The development of those alloys, innovative microstructural modifications and forming techniques, or other breakthroughs that promise to lower costs, is required for significant penetration into the automotive market.

A multidisciplinary team, including materials scientists, automotive engineers, and systems analysts, has been assembled for this project. The study will begin with a literature search to see what has been done in the past. Historical applications of magnesium alloys include

various truck bodies, such as the Metrolite that used sheet and extrusions extensively, the Volvo concept car, and the Volkswagen Beetle engine, which was made of cast magnesium. The study will continue by defining the characteristics required for component parts in different types of automotive systems. Material properties and performance required for each type by the automotive industry such as stiffness, crush behavior, corrosion resistance, fatigue resistance, nonflammability, and limited explosiveness will be identified.

The properties available in magnesium and its varied alloys will be characterized, noting possible extensions to improve desired properties. The range of parts made possible by different forming methods, at room or elevated temperatures, will be identified. We will identify and assess the potential of magnesium to meet production demands involving stamping, rolling, extrusion, hydroforming, forging, superplastic forming, finish machining, assembly, and finishing. Applications involving die-cast methods will not be investigated, unless some there is some novel aspect that would enable significant new applications. The vehicle requirements and possibilities available via magnesium and its alloys will be matched up to identify potential new areas for automotive uses of magnesium. ANL will identify technical and institutional constraints hindering the use of magnesium and alloys in automotive sheet and structural forms. Production cost barriers will also be identified based on current technology.

Directions for research to help alleviate some of the barriers will be identified. Results of this study will be presented at the 1995 Automotive Technology Development Contractors' Coordination Meeting.

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.