

ANNUAL PROJECT REPORT
AS OF DECEMBER 2001

1. Project Sponsor

Thompson Aluminum Casting Co., Inc.
5161 Canal Road
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2. Project Manager

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3. OCDO Grant No. CDO/D-98-1

4. FINAL REPORT

5. Project Title: Fly Ash Alloy Demonstration Project

6. Project Term: From 1/99 To 12/2001

7. Budget:

<u>Name</u>	<u>Cost Share</u>
Ohio Coal Development Office	\$1,500,000
Thompson Aluminum Casting Co., Inc.	725,000
Thermtronix Furnace Corporation	300,000
CHL Microspheres, Inc.	150,000
Camp, Inc. (replaced by EIO)	100,000
Eck Foundry	175,000
Dayton Power & Light	150,000
First Energy Corporation	50,000
Edison Materials Technology Center	2,500
Total Project Cost:	<u>\$3,150,000</u>

I. ABSTRACT

8. Overview of Project and Objectives:

The Thompson Aluminum Casting (TAC) Company and its partners in the foundry, electric utility, industrial equipment, automotive and commercial industries spearheaded a program to demonstrate clean coal technology by-product management in a pre-competitive, enabling technology that was aimed at:

- Expanding the use and implementing advanced materials for automotive and commercial use that incorporated clean coal technology by-products (fly ash)
- Additional energy savings and environmental/economic benefits; and
- Enhanced domestic technology and Ohio competitiveness.

This program applied newly enhanced technologies for aluminum “ashalloys”— metal matrix composites that incorporate coal fly ash with aluminum alloys — that has been proven feasible for the manufacture of cast automotive and commercial parts. As an additive, fly ash reduces weight and cost, improves selected material properties, reduces energy consumption and pollution, and overcomes the cost hurdle that has kept other metal matrix composites from wider use. Unfortunately, however, prior to gaining widespread use, the automotive and commercial industries have indicated that a proven “food chain” insuring a ready supply of the “ashalloy” material be demonstrated prior to specifying “ashalloy” components for use by their respective industry for selected components. This program addressed this concern by demonstrating that mass quantities of ashalloy materials are indeed capable of being produced.

9. Work Done & Conclusions:

The overall goal of the program was to incorporate moderately treated fly ash into aluminum matrix materials (common alloys) in quantities that represented manufacturing lot sizes. A number of iterations were tried using fly ash that was separated by size, density and make-up that was provided by both of the participating utility companies using a number of techniques. The program team established a number of findings as follows:

Firstly, that ashalloy can be produced in 3,000-pound batches employing stir-casting techniques in a low pressure, sealed furnace. Secondly, it was found that ashalloy with finely dispersed, non agglomerated ash content can be consistently produced from materials that have been preprocessed in a ball milling operation that provides a relatively low cost means of producing very fine ($\leq 5 \mu$) reinforcement (ash) materials embedded in aluminum particles. (The $\leq 5\mu$ size ash is the result of the ball milling process meaning that ash of various sizes larger than 5μ may be initially employed with the process reducing the ash to $\leq 5\mu$ size.) It was also found that certain other coating processes aided in the wetting of the ash, however, the added cost may eliminate these approaches from consideration. Thirdly, it was found that “master alloy” blocks consisting of magnesium(AZ 91) and fly ash can be produced which when added to the molten aluminum, permit good wetting and dispersion between the ash and the aluminum, and lastly, it was found that a chemical reaction can be induced between the aluminum and the fly ash which results in a very thermally stable product.

The ability to accomplish wetting was found to be the major obstacle in the program and though the use of a high shear mixing device did not achieve this end without a wetting agent such as magnesium, the production of materials with finely dispersed, non agglomerated ash particles was found to be possible when employing the high shear mixing device in combination with pre-treated ash particles. This pre-treatment included both a mechanical alloying process where the ash was ball-milled with aluminum powder and then added to the melt with magnesium chips, or added to molten magnesium, solidified into small billets and then stirred into the molten aluminum.

10. Plans for the Coming Year:

Project was completed in December 2001

II. Highlights and Accomplishments

11. Program Achievements included findings and conclusions that determined:
- a. Adding fly ash to the molten aluminum could be accomplished only when employing a high shear mixing device in conjunction with a wetting agent such as magnesium or a coating agent where wetting occurs.
 - b. Aluminum/Fly Ash materials with good dispersion and non-agglomeration of the ash are capable of being produced in large quantities when employing the ash pre-processing techniques utilized under the project.
 - c. The alloy produced, though costing more than non-reinforced materials, has property advantages over non-reinforced materials such as reduced Coefficient of Thermal Expansion.
 - d. Certain phenomena were discovered during the program that indicate the fly ash-aluminum alloy has significant property advantages over other reinforced materials for thermal fatigue.
 - e. The project had spin-off benefits as potential use of fly ash for other projects were established which resulted in the announcement that a new industrial firm would be located into one of Ohio's most depressed Appalachian counties that will clean and prepare fly ash for use on other projects.
 - f. The project has caused widespread interest both domestically and internationally resulting in a follow-on cooperative effort with the country of Poland who, like Ohio, relies upon coal fired power plants to produce almost all of her electric needs.

III. Articles and Presentations

- 12.
- a. Presentation of 2 Technical Papers and Poster Exhibit to Pittsburgh Coal Conference, September 2000.
 - b. Presentation of 2 Technical Papers to AMS International, October 2000.
 - c. Presentation to the Polish Utility Industry, May 2000 and Ministry of Economics, October 2000.