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Development of Weldable Superplastic Forming Aluminum Alloy Sheet Final Report CRADA No. TC-1086-95

D. Lesuer, T. C. Sun

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Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Development of Weldable Superplastic Forming Aluminum Alloy Sheet

Final Report
CRADA No. TC-1086-95
Date Technical Work Ended: December 23, 1999

Date: July 5, 2001 Revision: 3

A. Parties

This project was a relationship between Lawrence Livermore National Laboratory (LLNL) and Kaiser Aluminum & Chemical Corporation (Kaiser).

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Lawrence Livermore National Laboratory
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Kaiser Aluminum & Chemical Corporation
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B. Project Scope

Numerous applications could exist for superplastic formable, weldable aluminum alloys in the automotive, aerospace, architectural, and construction industries. In this project, LLNL and Kaiser worked with The Institute for Metals Superplasticity Problems to develop and evaluate weldable superplastic alloys. The Institute for Metals Superplasticity Problems (IMSP) located at Ufa, Russia was not a party to this CRADA, but performed tasks identified in the Statement of Work under a procurement from LLNL.

A multi-step series of evaluations was required to assess the potential of the alloys selected to be formed by superplastic deformation. Aluminum alloys 6061 and 2219 needed an aggressive search for applications and conversions from other materials and competitive low cost production routes, and were selected for this project because they were commercially important, weldable and had excellent corrosion resistance.

C. Technical Accomplishments

The two alloys selected for this project were developed for different applications. Alloy 6061 is weldable with low density and excellent corrosion resistance. As a superplastic metal, many new applications would be available for this alloy, particularly in the transportation industry. Alloy 2219 in a superplastic form would be weldable after forming and heat treating, and should have a significant commercial market.

Several compositions were cast as small ingots by conventional processes and fabricated to sheet for SPF property evaluation. Processing variables during fabrication were explored and optimized. After suitable properties were obtained on the small scale, the parties planned to scale up in several steps to full commercial ingot size and to optimize processing in a factory environment.

Under this project, LLNL was responsible for evaluating the superplastic deformation characteristics of the alloys and characterizing the microstructure at various stages of processing.

Numerous applications exist for superplastic formable, weldable aluminum alloys in the automotive, aerospace, architectural, and construction industries. In this project, LLNL and Kaiser worked together on the development of the necessary design and technical data for commercial applications. The Institute of Metals Superplasticity Problems (IMSP) at Ufa, Russia was not party to this CRADA, but performed tasks identified in the Statement of Work under procurement from LLNL.

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The FSU Institutes were responsible for development of the alloy processing, fabrication of the alloy sheets, evaluation of microstructure and other characteristics, including quench sensitivity, processing of commercial ingots, and optimization of processing and forming in a factory environment. Kaiser cast the standard U.S. composition ingots and participated in the characterization and evaluation of the superplastic alloys developed under this project.

D. Expected Economic Impact

D.1 Specific Benefits

The main advantage of SP forming is the ability to reduce the number of parts in a fabricated structure. For example, a car door may contain 12 or more sheet metal parts when formed by conventional techniques, but a superplastically formed door may contain only 2 or 3. Each part requires at least one set of two dies. Dies are expensive, and contribute heavily to the cost of a structure, especially for low volume production.

The relatively high cost SP forming (because it is relatively slow) could be largely offset by the die costs for conventional forming, however, the SPF parts still need to be joined to form the final structure. Welding is an inexpensive and effective method of joining if the alloy is weldable, as is the case for both alloys 6061 and 2219.

Successful development of these alloys would allow the Russians to:

1) Produce them for domestic and export markets
2) Use them as a springboard to start a new business in metal parts fabrication aimed at either domestic or export markets

Kaiser provided guidance in these business related areas. Kaiser Aluminum and Chemical Corporation (KACC) had offices in Moscow and Krasnoyarsk and extensive contacts with potential customers and investors. Kaiser also had significant internal experience with the product qualification procedures of automotive and aerospace customers.

Benefits to DOE Program

These projects were selected and were instructed to match laboratory core competencies and accomplished the following objectives that related to various LLNL missions:

1) Facilitated and supported defense conversion and nonproliferation activities
2) Promote free markets and economic growth in the National Independent States (NIS)
3) Encouraged the emergence of political and economic institutions in the NIS based on free enterprise
4) Potential to expand international markets for U.S. goods and services
5) Potential to enhance the international competitiveness of the U.S. private sector

E. Partner Contribution

Kaiser's facility was used initially for casting the ingots used in this project. Kaiser was responsible for casting standard US composition ingots and shipping them to Ufa. Kaiser also characterized the microstructure of the alloys; evaluated superplastic deformations characteristics of the alloys at various stages of the processing schedule; and provided technical data, processing information and material to potential end users.

F. Documents/Reference List

Reports

R.O. Kaibyshev (Institute for Metals Superplasticity Problems),
Final report on sub-contract B319897
"Development of Weldable Superplastic Forming Alloy Sheet"
December 23, 1999

R.O. Kaibyshev (Institute for Metals Superplasticity Problems)
Task reports 1 - 13 on sub-contract B319897
"Development of Weldable Superplastic Forming Alloy Sheet")
December 23, 1999

Patent/Copyright Activity

No patents filed

Subject Inventions

No inventions were disclosed

Background Intellectual Property

No BIP involved in this project

G. Acknowledgement

Participant's signature of the final report indicates the following:

1) The Participant has reviewed the final report and concurs with the statements made therein.
2) The Participant agrees that any modifications or changes from the initial proposal were discussed and agreed to during the term of the project.
3) The Participant certifies that all reports either completed or in process are listed and all subject inventions and the associated intellectual property protection measures generated by his/her respective company and attributable to the project have been disclosed and included in Section E or are included on a list attached to this report.
4) The Participant certifies that if tangible personal property was exchanged during the agreement, all has either been returned to the initial custodian or transferred permanently.
5) The Participant certifies that proprietary information has been returned or destroyed by LLNL.

T. C. Sun 10/3/2001

Dr. T. C. Sun Date
Manager of Product Technology
Kaiser Aluminum & Chemical Corporation

10/12/2001

Don Lesuer Date
Principal Investigator
Lawrence Livermore National Laboratory

Attachment I – Final Abstract

Development of Weldable Superplastic Forming Aluminum Alloy Sheet

Final Abstract (Attachment I)
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C. Benefits to Industry

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E. Project Dates

January 11, 1996: Sub-contract between the Institute for Metals Superplasticity Problems and the Regents of the University of California signed

March 1996 – April 1999: Task reports 1 – 13 submitted

October 29, 1996: Visit by Rustam Kaibyshev to Kaiser – Trentwood Washington Plant

December 23, 1999: Final report submitted