ALUMINUM

Project Fact Sheet

SUPERIOR ALUMINUM EXTRUSIONS

BENEFITS

The outcome of this project will result in a five percent increase in weight yield between the extrusion billet and final product. The product weight yield increase will result in the reduction of required billet material by 333 million pounds annually. The reduced need for material will result in:

- Annual energy savings of over 600 billion Btu by 2010
- Over 350,000 metric tons of carbon dioxide equivalent emissions eliminated annually by 2010

APPLICATIONS

The commercial application of aluminum extrusions impacts a significant portion of U.S. industry. Nearly 3.5 billion pounds of aluminum extrusions were produced and shipped by U.S. manufacturers in 1997. The major consumers of extruded aluminum products include the aerospace, ground transportation, and building industries.

ENERGY-EFFICIENT MANUFACTURING OF SUPERIOR ALUMINUM EXTRUSIONS

Current extrusion processes result in approximately a 30 percent loss of material from the initial billet to the final product. These losses are due to billet trimming, the inability to extrude the entire billet, and the extruded product not meeting material specifications. The extrusion process produces large deformations which affect the mechanical properties of the finished product, impacting the material's crystallographic texture, morphology and residual stress. The product's final characteristics are dependent upon a complex interaction of the alloy system and thermal and mechanical processing steps (billet temperature, extrusion speed, product cross-section, extrusion and final heat treatment, stretch straightening, etc.). Combining process and material property prediction models will improve the consistency and fundamental performance of extrusion operations. These improvements will result in fewer finishing steps and higher metal yields.

Project partners will investigate the extrusion production process and material property evolution. The partners will characterize extrusions and numerically model the production process to develop an enhanced understanding of the process/product interdependence. The numerical modeling will focus on the extrusion, final heat-treatment, and final straightening processes. They will investigate the contribution of the manufacturing process to final extrusion product characteristics and develop predictive technology that reduces extrusion property variability.

ALUMINUM EXTRUSION

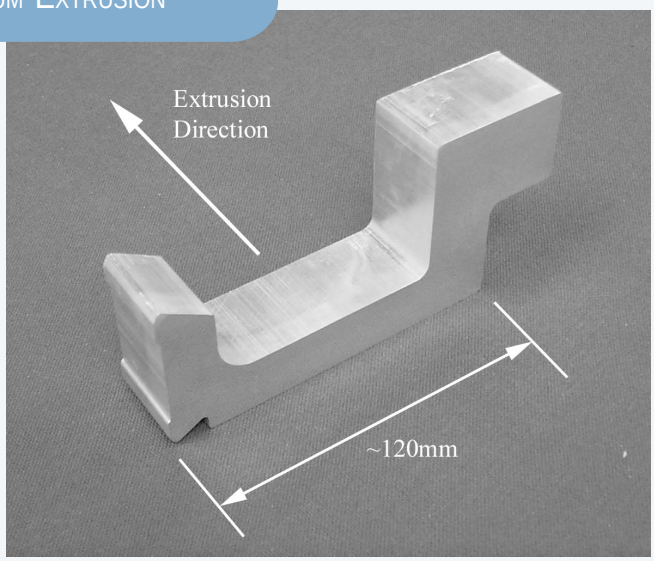

Image of a typical aluminum extrusion cross-section.

Project Description

Goal: The goal of this project is to develop extrusion process and property prediction models for aluminum alloy extrusions that will increase metal yield from 70 to 75 percent.

Progress and Milestones

Successful development of this technology will require the following steps:

Experimental Characterization of Extrusion Products

- Characterize extruded alloys through each of the major process steps using a combination of scanning and transmission electron microscopy.
- Characterize the evolution and the variations in crystallographic texture.
- Characterize and measure the residual stresses.
- Investigate the mechanical properties of extrusions as they evolve from billet to final product.

Material Model Development

- Develop material models that accurately describe the response of the materials during the multi-step manufacturing process.
- Implement the specific material models into existing manufacturing process simulation tools and use these tools to predict the evolution of microstructure characteristics during the extrusion manufacturing process.
- Develop anisotropic material models to describe the response of the materials during extrusion-straightening operations.

Numerical Modeling of Production Processes

- Integrate the material models developed into commercial finite element codes through subroutines.
- Demonstrate and validate the numerical models for the individual processes contributing to final extrusion product.

Combined Process Modeling and Property Prediction Validation

- Demonstrate the ability of the combined process models to predict accurately the effects of the key process parameters on the mechanical and physical properties of a commercially representative extrusion shape.
- Demonstrate the use of the codes as a tool for further optimizing the manufacturing process to obtain more desirable and repeatable extrusion properties.
- Improve the extrusion processing steps and then demonstrate for select extrusion shapes using the models developed and validated in the previous task.

Commercialization Plan

This project involves collaboration between the world's largest supplier and consumer of aluminum extrusion products. The project includes research staff and manufacturing process development engineers contributing to and integrated into the overall effort. The partners developing and controlling the process will have immediate access to developments made during the project.

Project Partners

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Alcoa Center, PA

Lawrence Livermore National Laboratory
Livermore, CA

Oak Ridge National Laboratory
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