ALUMINUM

Project Fact Sheet

Alloy Surface Behavior

Benefits

Better understanding of surface behavior, metallurgy and process parameters would permit:

- An energy savings of 650 billion Btu per year
- A cumulative environmental emissions reduction of over 1 million pounds (CO_2, CO, SO_x, NO_x, PM, Residue)
- An estimated 2 percent increase in aluminum recovery (reduction in scrap) which would result in extrusion scrap reduction of 85 million pounds per year
- An estimated 5 percent increase in extrusion speed (perhaps even higher for the hard-alloy segment)
- A total cost savings to the U.S. aluminum industry of $50 million per year
- Thinner-walled extrusions

Applications

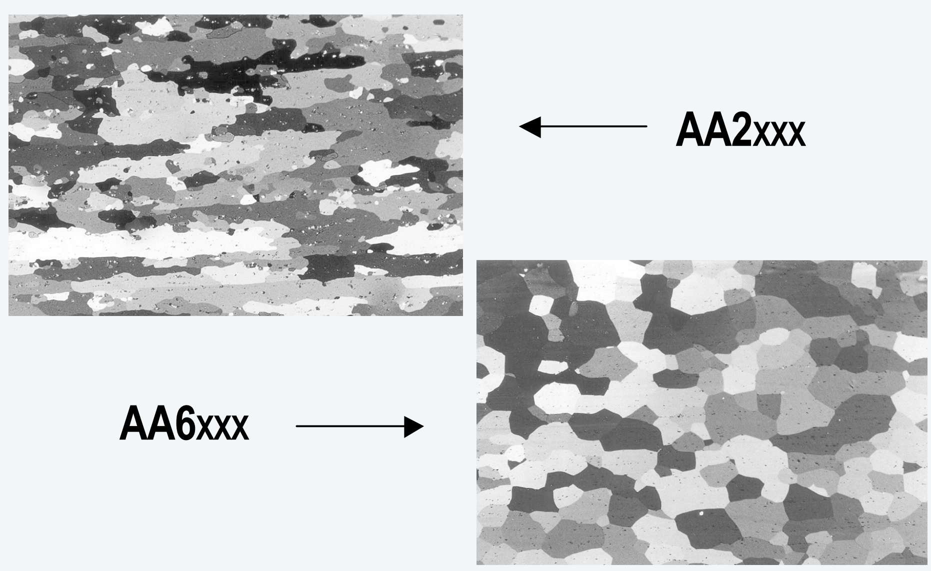
The needs that the proposed program addresses are primarily in the semi-fabricated and fabricated sector of the aluminum industry. The development of this technology will benefit U.S. aluminum producers of rolled and extruded products.

Surface behavior of aluminum alloys deformed under various processing conditions

Understanding the origins and mechanisms that control surface quality in formed aluminum products can help industry to reduce scrap, improve process efficiency, lower production costs, and save energy. Formed products are produced by complex thermo-mechanical deformation operations such as rolling and extrusion. These metal forming operations can create surface flaws which affect surface anodizing and coating. Demand is rapidly growing for high quality formed aluminum products in the automotive and aerospace industries. Surface quality is part of the formed aluminum product specifications and is of comparable importance to mechanical properties and alloy composition.

Establishing a relationship between process parameters and surface microstructure changes will allow better control, prediction, and reproducibility of the surface quality produced from aluminum rolling and extrusion processes. Surface imperfections such as course grain, orange peel, cracking, and tearing result in the rejection of formed products. This research will lead to an understanding of the complex microstructure change and process parameter relationships. This understanding will make possible an increase in extrusion and rolling rates while also increasing product yield.

Microstructure Evolution



Micrographs showing the microstructure evolution after hot rolling and annealing of alloys AA2xxx (Al-Cu-Si-Mn) and AA6xxx (Al-Si-Mg).

Project Description

Goals: The goal of this research is to establish a relationship between surface behavior, metallurgy, and process parameters in deformed aluminum alloys.

The proposed investigations will determine the fundamentals controlling surface microstructure development for rolling and extrusion processes. The objective is to understand the origins and mechanisms of the formation of surface phenomena including surface recrystallization and surface fracture.

The knowledge generated could be characterized in two groups. The first group will provide detailed knowledge on how to develop microstructural response models for surface behavior, including phase kinetics of precipitates, surface recrystallization, and surface fracture. The second group will provide detailed knowledge on how to integrate the microstructural response models with process models as a design package. The improved understanding of the role of the various processing parameters will initiate economic, energy, and environmental benefits.

Progress and Milestones

- Laboratory Deformation Tests - Perform deformation tests that most closely simulate conditions during industrial processes. Based on these tests, the critical conditions for the onset of surface imperfections can be determined.
- Extrusion and Rolling Tests - Simulate the evolution of metastable second phase precipitates and dipersoids during deformation. Determine the effect of dipersoids on the formation of recrystallized grains.
- Characterization - Characterize the phase evolution and texture of deformed and recrystallized grains after deformation.
- Model Development - Create a material response model based on the data that will be able to predict microstructure and texture during deformation.
- Model Verification - Verify the model under various process conditions in rolling and extrusion.
- Industrial Implementation - Implement the model into industrial practice.

Commercialization Plan

The technology developed under this research will be made available to the aluminum community through journal publications and/or technical presentations. Industry will incorporate this knowledge as an off-line microstructural tool to guide process design of aluminum alloys.

Project Partners

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