METAL CASTING

Project Fact Sheet

Grain Refinement of Permanent Mold Cast Copper-base Alloys

Grain refinement will reduce hot tearing while increasing casting fluidity and pressure tightness

Grain refinement is a well-established process for many cast alloys, especially aluminum, resulting in enhanced casting characteristics and improved mechanical properties. Grain refinement of copper-base alloys in permanent mold casting process is fairly new and is aimed at improving the hot tearing resistance.

Preliminary research has shown that the mechanism of grain refinement in copper-base alloys is not well understood. This lack of understanding extends to the interaction between the grain refiner and minor elements present in copper alloys, such as Sn, Al, Bi, Se, and Pb. The evaluation of nuclei formation which causes the grain refinement in copper alloys is also necessary.

The Copper Development Association and industry partners will conduct a series of research tasks to understand grain refinement behavior of permanent mold copper-base alloys. This will increase casting fluidity, reduce hot tearing, and increase pressure tightness. This will in turn result in higher casting yield in foundries. The project will greatly improve the ability to produce components for plumbing and other applications while responding to environmental issues surrounding lead in plumbing components and foundry sand.

Benefits

There are a number of benefits resulting from this project:

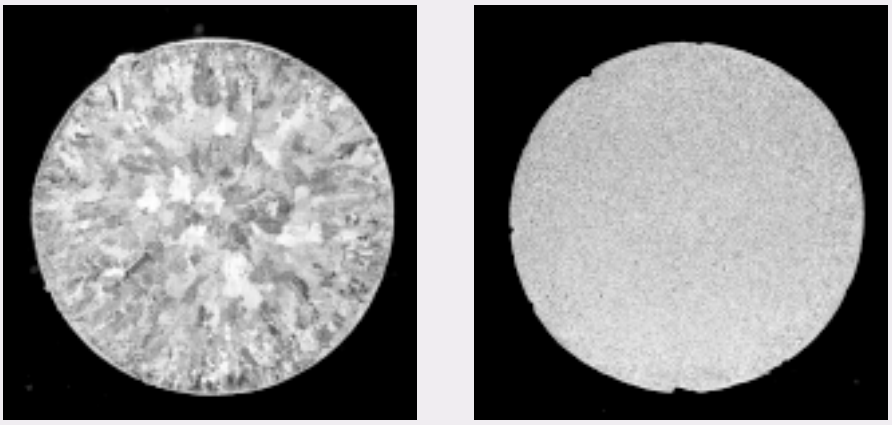
- Grain refinement will result in higher casting yield in foundries.
- Thermal analysis technique will serve as a quality control tool in evaluating the cleanliness of melts before commencing with casting operations. This will reduce overall scrap rates.
- Near net-shape components could be produced by permanent mold casting thus reducing machining and finishing costs.
- The maximum allowable limits for elemental impurities determined from this project could be used in standards to ensure premium quality castings free of hard spots.

The results of this project will also enable increased production of plumbing castings by way of permanent mold castings versus sand castings. This will help address the restrictions on lead in drinking water as well as foundry sand contamination issues.

Applications

In place of energy-intensive sand casting, the permanent mold casting process is a better alternative to produce plumbing components. Grain refinement of copper base alloys also improves the casting characteristics of permanent mold castings.

Base Alloy and Grain Refined Alloy



Base Alloy | Grain Refined Alloy

Macrostructures of yellow brass refined by boron, 5x.

Showcase Description

Goal: The goal of this project is to evaluate the grain refinement characteristics of four permanent mold cast copper-base alloys, namely SeBiLOY III (C89550), yellow brass (C85800), silicon brass (C87500) and silicon bronze (C87600). This evaluation will serve as a means for improving hot tearing resistance in these alloys.

Progress and Milestones

This three year project was awarded in August 2000. Planned activities include:

- **Grain Refinement** – The grain refinement behavior of lead-free SeBiloy III, leaded yellow brass, silicon brass and silicon bronze will be evaluated. Different grain refiners will be added to evaluate the effectiveness of the additions. The loss of grain refinement (fading) during holding, remelting and change mixing will be studied for yellow brass, silicon brass, and silicon bronze.

- **Hard Spot Formation** – The effect of impurity elements and grain refiners on the formation of hard spots will be evaluated. A thermal analysis technique will be developed as a quality control tool to predict and identify grain refinement and hard spot precipitation. The nuclei present and the hard spots in the grain-refined alloys will be analyzed using optical and electron microscopes.

- **Corrosion Behavior** – The corrosion behavior of the grain-refined alloys will be evaluated in different city water conditions using potentiodynamic polarization and weight loss techniques.

Project Partners

Copper Development Assn., New York, NY

Materials Technology Laboratory (CANMET) Ottawa, Ontario

American Foundry Society, Des Plaines, IL

A.B. Chance, Centralia, MO

Brass and Bronze Ingot Manufacturers, Chicago, IL

Brost Foundry, Cleveland, OH

H. Kramer & Co., Chicago, IL

IMR USA, Sheboygan, WI

International Copper Association, New York, NY

Kirit Dave (Consultant), Naperville, IL

Kohler, Kohler, WI

L. Fazekas & Models, Brantford, Ontario

PIAD Precision Casting, Greensburg, PA

R. Lavin & Sons, Chicago, IL

Sloan Valve, Augusta, AR

Starline Manufacturing, Milwaukee, WI

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