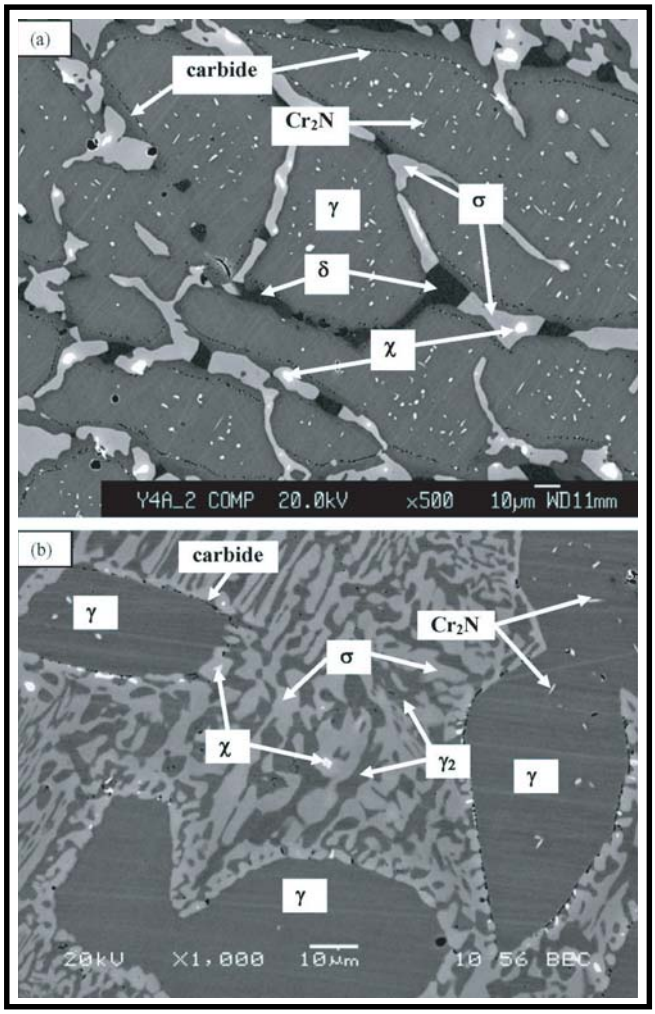
Industrial Technologies Program

Developments of Continuous Cooling Transformation (CCT) Diagram

A determination of the phases expected during cooling, as well as the development of reliable TTT and CCT diagrams, is of prime importance. Such information is the basis for proper control and processing of castings as they move from the initial melt to the finished product. In addition, TTT and CCT diagrams are crucial for determining the most economical heat treatment and cooling schedules. Successful determination of such diagrams, and the development of suitable models based upon them are expected to result in considerable energy savings as material is processed through the foundry.

They are also applicable to a wide range of parts since they are alloy-specific, rather than product-specific. Since TTT and CCT diagrams are alloy-specific, a research team led by Iowa State University will correlate experimental results with simulated results based on thermodynamic calculations. If successful, the research team will predict CCT diagrams for alloys not yet studied.



Back scattered electron (BSE) image of (a) CD3MN annealed for 30 days and (b) CD3MWCuN annealed for three days. Chi phase brighter than sigma in MSE image.

Benefits for Our Industry and Our Nation

- *More economical heating and cooling schedules.*
- *Significant energy savings.*
- *Applicability to a wide range of parts.*

Applications in Our Nation's Industry

This research will provide proper control and processing of steel castings. It will assist steel foundries in determining the most economical heat treating and cooling schedules. This work is also applicable to a wide range of parts since they are alloy-specific, rather than product-specific.

Project Description

The project will involve two distinct, yet highly integrated components. These components are metallographic observation of heat-treated samples coupled with thermodynamic modeling of the observed structures.

The specific goals of the proposed projects are:

- Determine the time-temperature-transformation (TTT) diagrams for the superaustenitic stainless steel casting alloys CK-MCuN and CN-3MN.
- Determine the continuous cooling transformation (CCT) diagrams for the same alloys.
- Utilize thermodynamic modeling to aid in the interpretation of the determined TTT and CCT diagrams from the standpoint of understanding the effects of alloy composition on the times and temperatures for the various transformations.
- Develop empirical models that predict the phase constitution of the alloys for a given cooling rate or isothermal hold.

Milestones

1. Obtain samples for heat treatments, and begin checking compositions.
2. Begin experimental heat treatments for TTT determinations for Alloy #1. Complete composition checks
3. Complete short-term heat treatments, continue long-term treatments.
4. Complete initial heat treatments. Determine Alloy #2 completed. Initial models of both alloy systems refined. Predictive capabilities of Thermo-Calc tested.
5. Enroll Student #2, Obtain samples of Alloy #2, begin GDS training. Student #1 begins CCT determination heat treatments.
6. Student #2 completes composition checks for Alloy #2. Student #1 begins Thermo-Calc modeling efforts for Alloy #1.
7. Student #1 completes CCT diagram for Alloy #1. Student #2 begins TTT determination heat treatments of Alloy #2.
8. Student #2 completes short-term treatments.
9. Initial TTT determined for Alloy #2. CCT treatments begun. Thermo-Calc efforts begin on both alloys.
10. CCT Diagrams for Alloy #2 completed. Initial models of both alloy systems refined. Predictive capabilities of Thermo-Calc tested.

Project Partners

Iowa State University
Ames, IA

Steel Founders Society of America
Crystal Lake, IL

Cast Metals Coalition Partnership
Charleston, SC

Allegheny Ludlum
Pittsburgh, PA

John Deere
Moline, IL

LECO
St. Joseph, MI

Stainless Foundry & Eng.,
Milwaukee, WI

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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