Research Programs

X-Ray Fluorescence Identification of Molten Aluminum Composition

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Introduction

Currently, there are no commercially proven methods for in situ analysis of molten aluminum chemistry. Although there are many methods for determining the composition of solid aluminum, only limited data is available for molten aluminum compositional analysis. wTe is leading a team of researchers to apply Laser Induced Breakdown Spectroscopy (LIBS) and X-Ray Florescence (XRF) Spectroscopy to fill this technology gap. An important part of this research is to establish methods for determining the accuracy and precision with which alloy composition can be measured using these two techniques. In situ analysis of molten aluminum will reduce processing time and ultimately save energy and money for aluminum processing.

Objectives

This research seeks to contribute to developing combined XRF and LIBS technology for in situ compositional analysis of molten aluminum. These contributions are expected to:

- Establish a method of instrumentation and data analysis for XRF to determine aluminum melt composition;
- Identify and quantify the error producing steps in the method using statistical testing for equipment stability and analysis of variance for the method;
- Investigate alloys within the aluminum 380 series and determine the statistical variation of at least two and up to four major alloying elements on XRF and selected LIBS measurements taken under ideal conditions;
- After determining the statistical variation under ideal conditions, vary the experimental factors that degrade the quality of the measurement to determine how each influences accuracy and precision. These factors include temperature of the melt and melt chamber atmosphere;

- Understand how characteristic emission line intensities are converted to elemental concentration by use of background subtraction, least squares fitting, background correlation functions, separation of peak overlaps etc., in order to determine the most suitable calibration procedure.

Methodology

The objectives listed above will be accomplished through a rigorous set of orthogonal fractional factorial experiments varying the major alloying elements of the aluminum 380 alloy series including Si, Fe, Cu, and Zn; other alloying elements will be held constant.

The method of instrumentation and data analysis will be developed based on first principles and lessons learned from past programs at wTe Corporation. The effect of temperature on experimental results will be investigated by varying melt temperature within the range used in commercial foundries and the atmosphere above the melt will be perturbed until the XRF signal cannot be detected. Using prior developed XRF Quantitative Analysis Software and a combination of first principles, a suitable method for calibration will be developed for identifying the actual composition of metal within the allowable alloy limits for the 380 alloy series, one of the most widely used alloy groups.