In-Situ, Real Time Measurement of Melt Constituents

New Laser System Provides Real-Time Measurements for Improved Product Quality Control

A new probe uses laser-induced breakdown spectroscopy (LIBS) to determine the elemental constituents in an aluminum, glass, and steel melt. This probe measures continuously and in-situ at any point in the melt, thus providing spatial and temporal real-time data. The probe uses a pulsed (5-10 ns duration) Nd:YAG laser at 532 nm that is focused, through a fiber-optic cable, into a molten aluminum sample, generating high-temperature plasma consisting of excited neutral atoms, ions, and electrons. Any chemical compounds present in the sample are rapidly separated into their constituent elements. The laser-generated plasma is allowed to equilibrate several microseconds after the laser pulse, and then a spectrograph fitted with an intensified charge-coupled array detector collects and disperses optical emissions from neutral and ionized atoms. The line radiation signal amplitude is calibrated quantitatively, thus providing the concentration of each element present.

In the glass industry, the probe can be used to monitor 1) trace alkali metal content in electronic glasses, 2) glass compositions to meet the defined specifications for waste-vitrified glasses and sealing glasses, and 3) the concentration of refractory dissolved in the glass to diagnose the state of the furnace. The probe has several applications in the aluminum and steel industries. For example, the probe can be used for in-line alloying to measure chemical content during a pour and for continuous and semi-continuous furnace operations to minimize the current practice of off-line sampling and measurement. In other applications, the probe can perform in-line monitoring of impurity removal from the melt, such as removing magnesium from molten aluminum, and can provide real-time data to validate computer simulations and model furnaces.

Benefits

Productivity

Determining melt constituents and temperature in-situ, real-time, and simultaneously eliminates the aluminum and steel furnace idle time now required for off-line measurement of melt constituents.

Product Quality

Providing data for use in a feedback control loop to control the furnace operation in real time increases product quality.

Overview

- Developed by Energy Research Company
- Marketed by Solios Thermal for the aluminum industry
- Installed on an aluminum melt furnace in 2003
- Installed on a glass melt furnace in 2004

Energy Savings

(Trillion Btu)

Cumulative through 2003	2003
0.037	0.037

Emissions Reductions

(Thousand Tons, 2003)

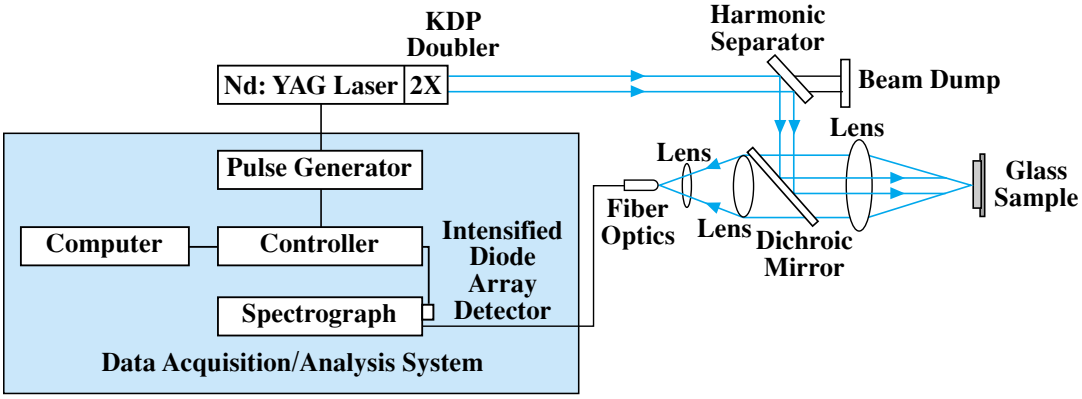
Particulates	SO_X	NO_X	Carbon
0.0	0.0	0.004	0.587

Applications

Identifies elemental constituents in metal and glass melts during the alloying and fabrication process

Capabilities

- Allows 10 to 50 measurements/second at a commercial cost (~$10k) similar to solid state lasers
- Measures aluminum melt constituents with 5% accuracy and a 0.002% minimum detection limit.
- Monitors trace alkali metal content in electronic glass compositions.



Laser-Induced Breakdown Spectroscopy System

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