Real Time Measurement of Glass Batch and Individual Ingredients

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ERCo has developed a laser-based technology for rapid compositional measurements of glass batch and in-situ measurements of molten glass. This technology, termed LIBS (Laser Induced Breakdown Spectroscopy) can determine whether or not the batch was formulated accurately in order to control glass quality. It can also be used to determine if individual batch ingredients are within specifications. In-situ compositional measurements of molten glass are achieved through immersing a LIBS probe directly into the melt in a glass furnace. This technology has been successfully demonstrated in ERCo's LIBS laboratory for batch analysis, cullet sorting, and glass melt measurements. A commercial batch analyzer has been operating in a PPG fiberglass plant.

LIBS is a laser-based method for measuring elemental composition in virtually any material, accelerating the decision making process on line. For example, an operator can monitor boron, sodium, calcium, aluminum, and other concentrations so corrective action can be taken. You are always in control of your process.

The results are improved product quality, better consistency of feedstock and cullet, reduction in scrap, and process waste, and avoidance of expensive downtime on the production line.

Features of the ERCo LIBS Batch Analyzer

- High accuracies and repeatability for all oxides, including boron
- Fluorine analysis
- All concentrations measured simultaneously
- Operates on only a few grams of material
- User-friendly "One Click" software
- Low maintenance
- Compact design
- Operator is alerted when control limits are exceeded.
- Data archived for process analysis
- Continues on-line analysis for single material
- Off-line analysis for multiple materials
- Molten glass measurement under development

LIBS utilizes a highly concentrated laser pulse to rapidly vaporize and ionize nanograms of the material being studied. As this vapor cools, it radiates light at specific wavelengths corresponding to the elemental constituents (e.g. silicon, aluminum, iron) of the material. The strengths of the emissions correlate to the concentrations of each of the elemental constituents.

By collecting the radiated light with a spectrometer capable of resolving and measuring these wavelengths, the elemental composition of the sample is found.

The LIBS System can be used as an on-line sensor as shown in Figure 1. In this configuration the LIBS System continuously measures a single material as it is flowing across a conveyor belt.

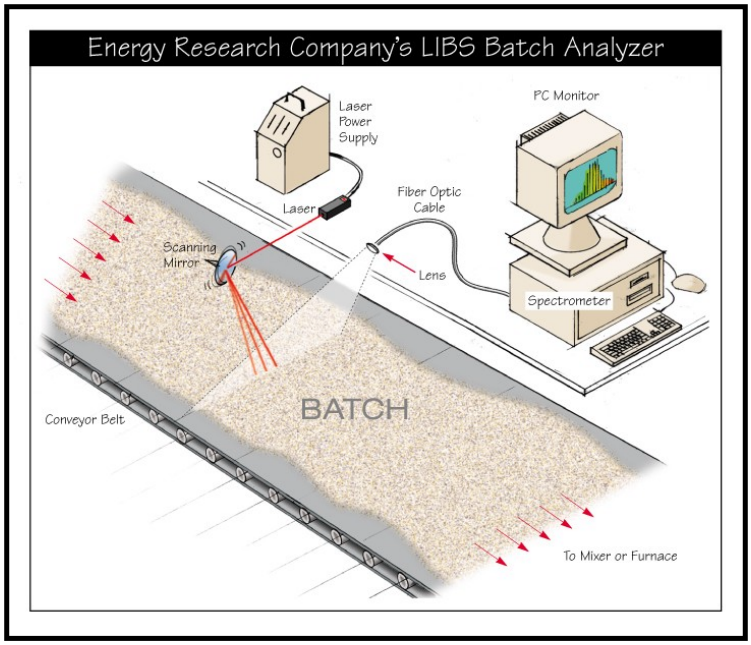

Figure 1 - ERCo's On-Line LIBS System

Figure 2 shows the LIBS System in an off-line configuration at PPG's plant. Here, samples from several different materials are brought to it for measurement. The results of boron in ulexite are shown in Figure 3 and other results are summarized in Table 1. In the figure the open circles represent data provided by the mining company and the solid circles are the LIBS analyzer results. The average relative difference between the measured and reported values was less than 2% for all major constituents, less than 5% for the minor constituents, and was within the acceptable measurement limits for the trace elements.

Figure 2 - ERCo's Off-Line LIBS System at PPG

Table 1 - Comparison of Mining Company and ERCo Batch Analyzer Ulexite Concentrations (all results are in relative % except trace element differences which are in absolute %)

Element	Ulexite Component	Average Discrepancy Between Reported and Measured Values
Boron	Major	0.35%
Calcium	Major	0.50%
Sodium	Major	1.83%
Silicon	Minor	4.03%
Magnesium	Minor	2.52%
Strontium	Trace	*0.027*
Aluminum	*Trace*	*0.007*
Iron	*Trace*	*0.002*

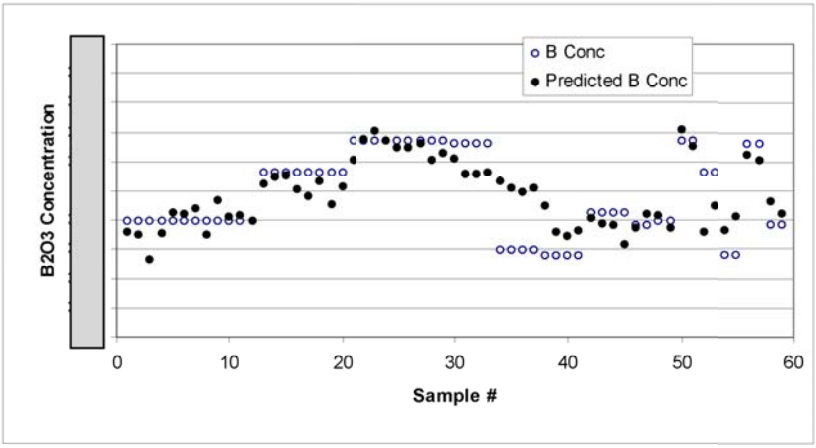

Figure 3 -LIBS Measurements of Boron In Ulexite

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