APPLICATION NOTE
1 / 2025

LIGHTIGO

Detection of Lithium in Concrete utilizing LIBS

Sample
Concrete pellets

Limits of Detection
90 ppb

Elements of interest
Li

Spatial resolution
100 µm

Mode of analysis
Multi-spot and 2D mapping

Measurement rate
20 Hz

Lithium plays a multifaceted role in influencing the properties of **concrete**, from its impact on clinker formation in cement kilns to its integration through supplementary cementitious materials like blast furnace, slag and industrial by-products.

In cement kilns, lithium reduces the decomposition temperature of limestone and lowers the initial melt formation temperature, enhancing energy efficiency during clinker production. Another approach involves incorporating chemical admixtures, such as lithium nitrate and lithium hydroxide, directly into the concrete mix.

These lithium compounds protect reactive silica grains by forming a protective layer that inhibits reactions with sodium and potassium hydroxides, effectively mitigating alkali-silica reactions. While these benefits significantly enhance concrete durability, large-scale applications are limited by lithium's high cost. To address this, laser-induced breakdown spectroscopy (LIBS) has emerged as a powerful method for lithium detection, offering fast, flexible, and precise multi-elemental analysis with minimal sample preparation, enabling advancements in concrete technology.

Calibration Curve

To prepare the calibration samples, ordinary Portland Cement was mixed with varying contents of Li_2CO_3 dissolved in distilled water, as outlined in Table 1. The resulting calibration curve is presented in Figure 1, with a detection limit of 0.09 ppm.

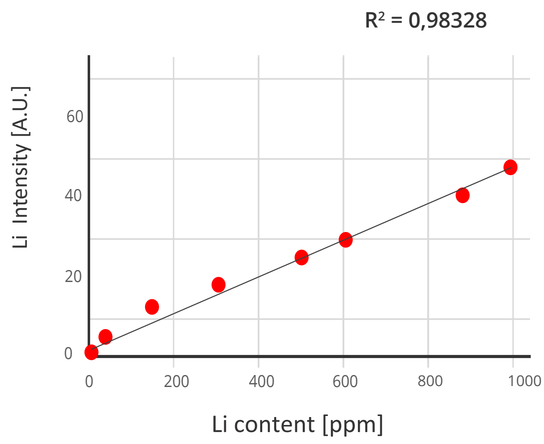

Fig. 1. Li calibration curve, determined by Lightigo LIBS System.

After an ageing period, the samples were cut into smaller pieces, exposing freshly created surfaces for analysis using laser-induced breakdown spectroscopy (LIBS). A 266 nm laser was employed, with measurements focused on the lithium spectral line Li I 670.78 and its intensity.

Table 1.: Samples

Sample	**Li content** [ppm]
1	0
2	10
3	150
4	300
5	450
6	600
7	900
8	1000

Elemental mapping

Figure 2. illustrates lithium distribution within a concrete sample as measured by the Lightigo LIBS system. The top panel shows the physical structure of the sample, highlighting aggregates embedded in the cement paste matrix.

The bottom part presents an elemental map of lithium concentrations, where the intensity of the signal is represented by a colour scale ranging from blue (low or undetectable lithium levels) to red (high lithium concentrations). This map reveals the heterogeneous distribution of Lithium in the sample, with elevated concentrations observed in specific regions. Capability of fast large area scanning (100×100 mm in case of FireFly) and the fine spatial resolution (20-100 μm typically) belongs to the benefits of the LIBS technology in Lightigo instruments. As demonstrated here, LIBS can be used to detect and visualise lithium in complex, heterogeneous materials like concrete.

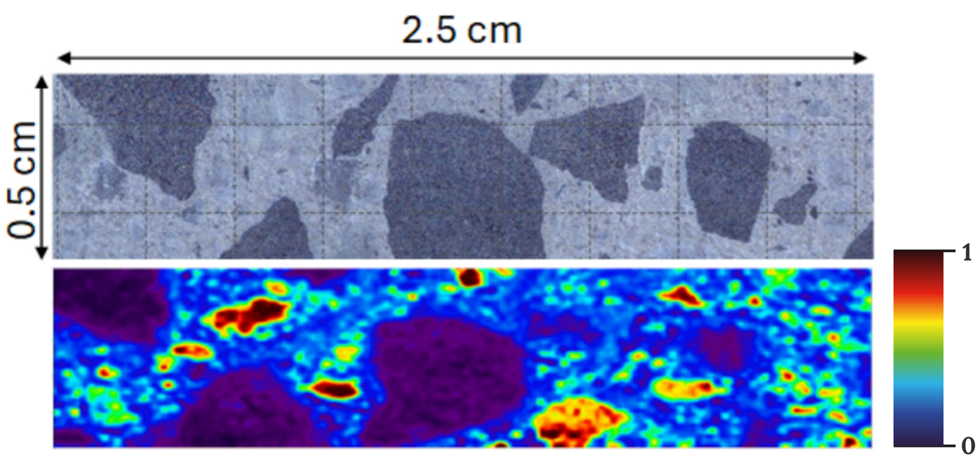

Figure 2. LIBS Example of Lithium distribution in concrete sample (support sill).

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