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## VII.3 - Division Building Diagnostic; Non-Destructive Testing in Civil Engineering



Photograph

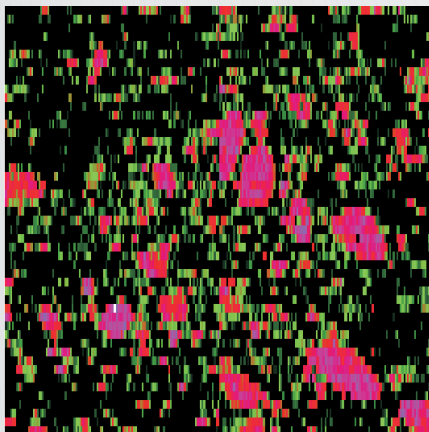
### Area Scan

An area-scan of a broken concrete surface (see photograph right) was measured to identify the spatial distribution of the main components. The surface ( $10 \times 10 \text{ cm}^2$ ) was scanned line by line, taking a spectrum at each point with a vertical resolution of 2 mm (50 lines) and a horizontal resolution of 0.4 mm (250 measurements per line). The three figures below visualize the spatial distribution of the intensities of Calcium, Silicon and Carbon.

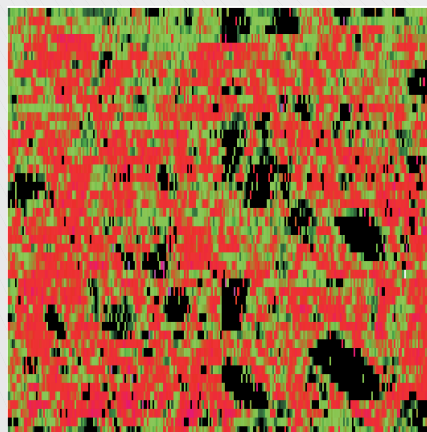
### Carbonation

Carbonation is the enrichment of carbon from the air in the near surface regions of concrete. This enrichment can be found with LIBS. See below an area scan of a broken concrete surface and the visualization of the carbon distribution (right figure).

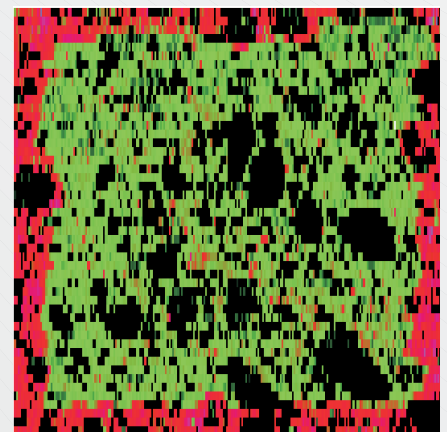
Silicon = 207,2 nm



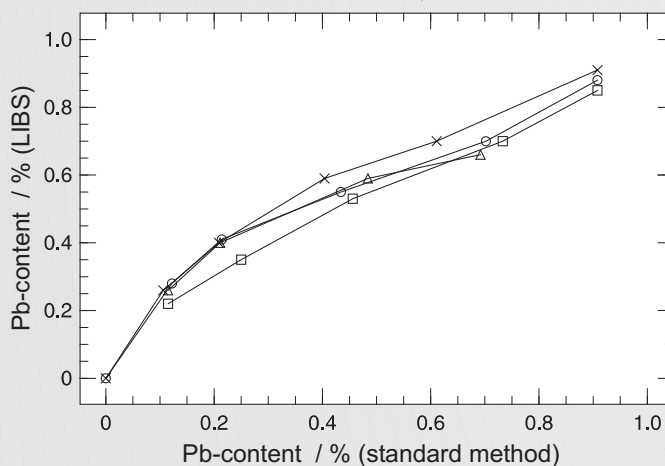
Calcium = 210,3 nm



Carbon = 193,1 nm



Lead = 405,4 nm



0 Intensity / a.u.

### Lead Content in Mortar Specimens

In the diagram on the left the relative amount of Lead in mortar specimens is plotted as measured with LIBS versus the Lead content found by the standard chemical method (AAS). The four series of data correspond to samples with different contents of zeolites.

## Summary and Outlook

LIBS is a surface method which can be used on solid specimens without preparation of the samples.

LIBS can measure with high geometrical resolution and imaging the elements distribution on surfaces of building materials.

LIBS can be used to characterize building materials, e.g.

- measure salt profiles and Lead content
- identify the type of cement used
- characterize concrete

Advanced detection devices (Echelle Spectrograph) enables the simultaneous measurement of a wide spectral range with high spectral resolution. Thus more elements can be identified with a single laser pulse and calibration can be done using more spectral lines.

LIBS can be used for analyzing building materials on-site and in real time. Quantitative measurements are possible.