

Ion distribution in concrete overlay, mapped by laser induced breakdown spectroscopy (LIBS), modified by an embedded zinc anode

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00 CONTENT

01 EZA - CONCEPT

02 QEZAC PROPERTIES

03 EXPERIMENTAL SETUP

04 GALVANIC PERFORMANCE

05 PRINCIPLE OF LIBS

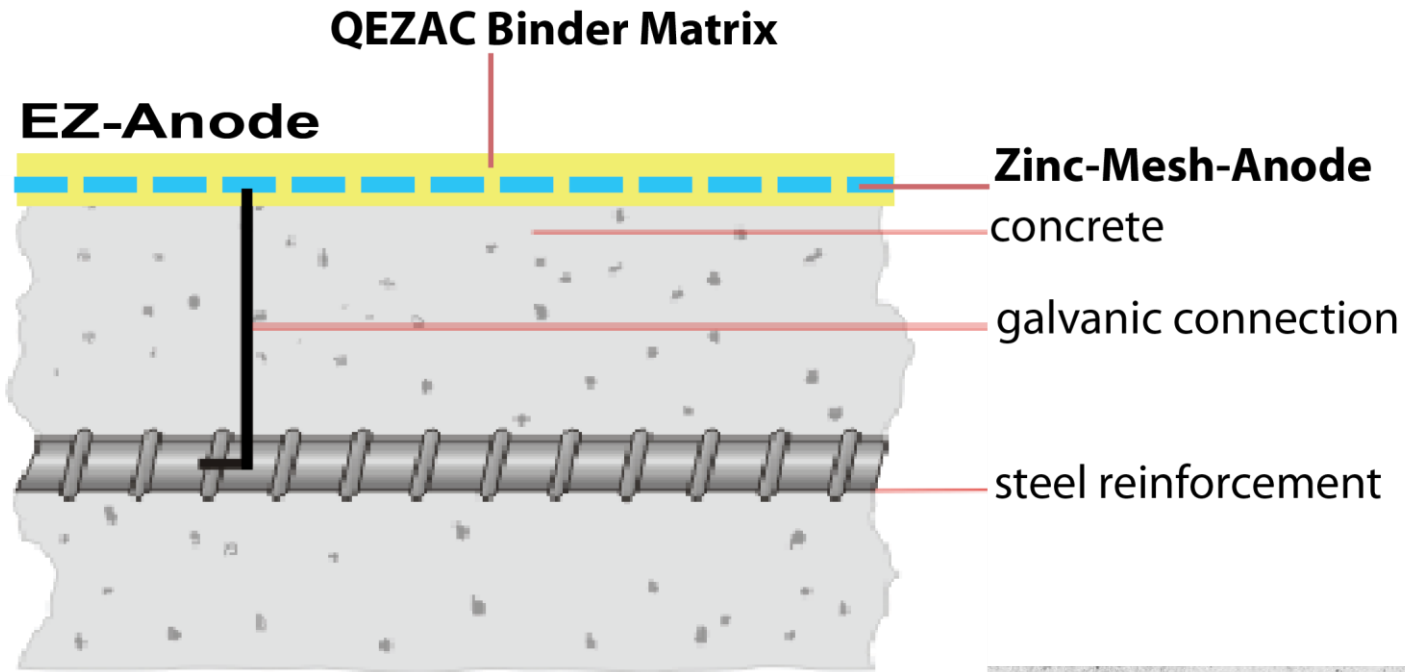
06 CHLORIDE DISTRIBUTION

07 ION DISTRIBUTION

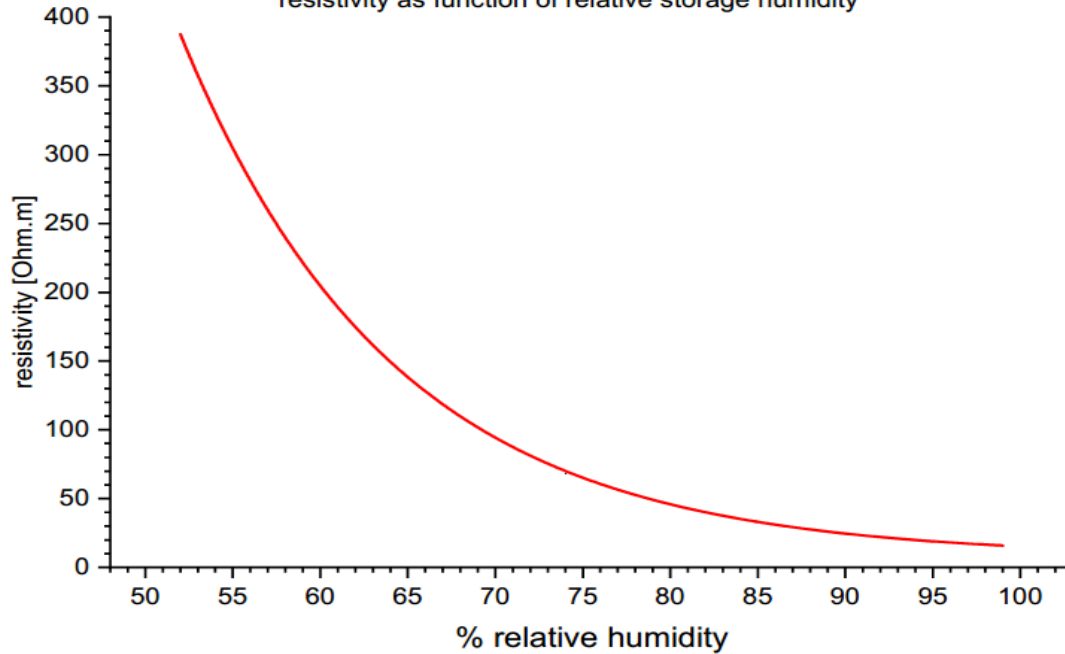
08 CONCLUSIONS



EZ-Anode – Embedded Zinc Anode



SEZAC binder 07-07-2017
resistivity as function of relative storage humidity



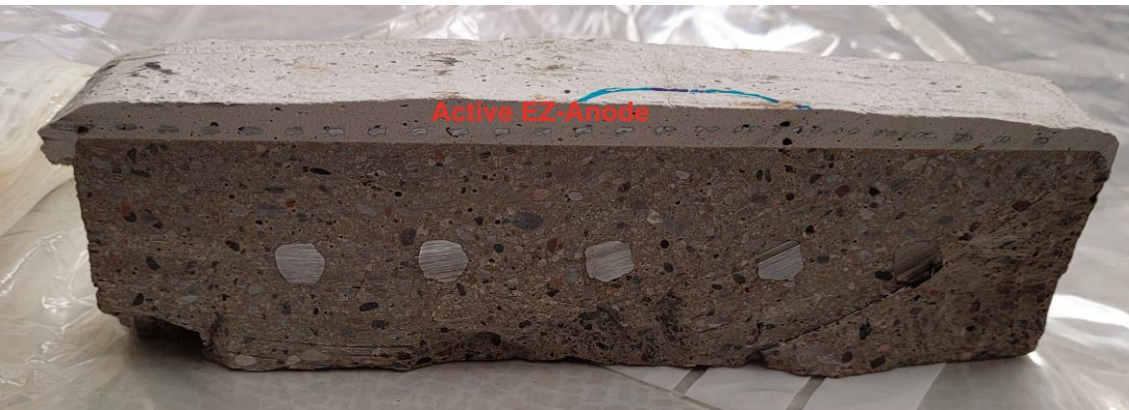
Binder Matrix TASC/SEZAC

SEZAC - Shrinkage reduced
Embedding Zinc Anode Cement

Function:

- ✓ embedding matrix for zinc mesh
- ✓ glue
- ✓ coating
- ✓ electrolyte
- ✓ activates zinc at pH < 12
- ✓ transport of anodic products into the matrix
- ✓ accomodates anodic products – porosity 35 – 45 Vol%
- ✓ minimizes autocorrosion





Studied under laboratory conditions:
Mortar (SikaMonotop 612N with 3,5% Chloride/wt. Cem.), zinc mesh embedded into SEZAC (chloride free embedding binder).



Samples studied after 2,5 years operation at about 75 % rh & RT:

- One specimen with active EZ-Anode
- One specimen with non activated EZ-Anode



Bundesanstalt für
Materialforschung
und -prüfung

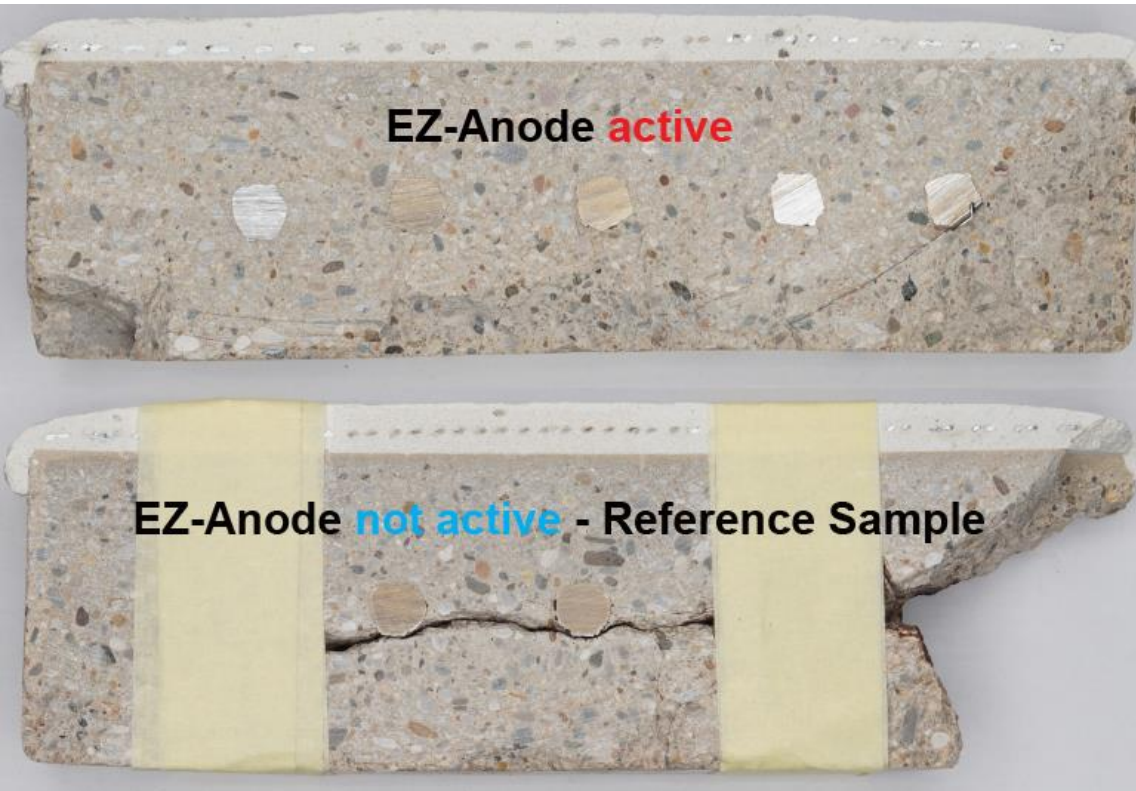
ION MIGRATION BY LIBS

Studied under laboratory
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Mortar (SikaMonotop 612N with
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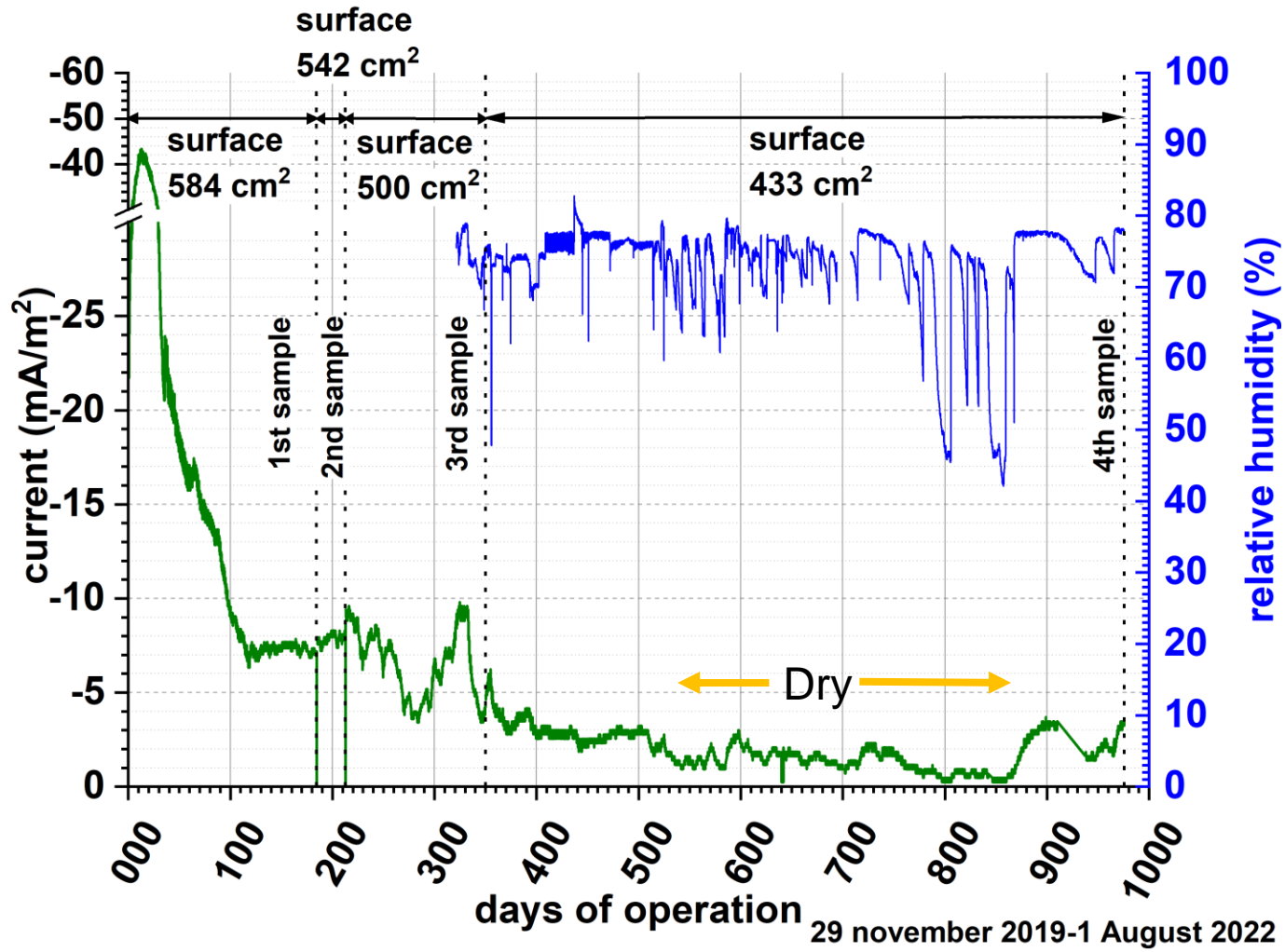
Element Analysis by **LIBS**

Laser Breakdown Spectroscopy
at BAM

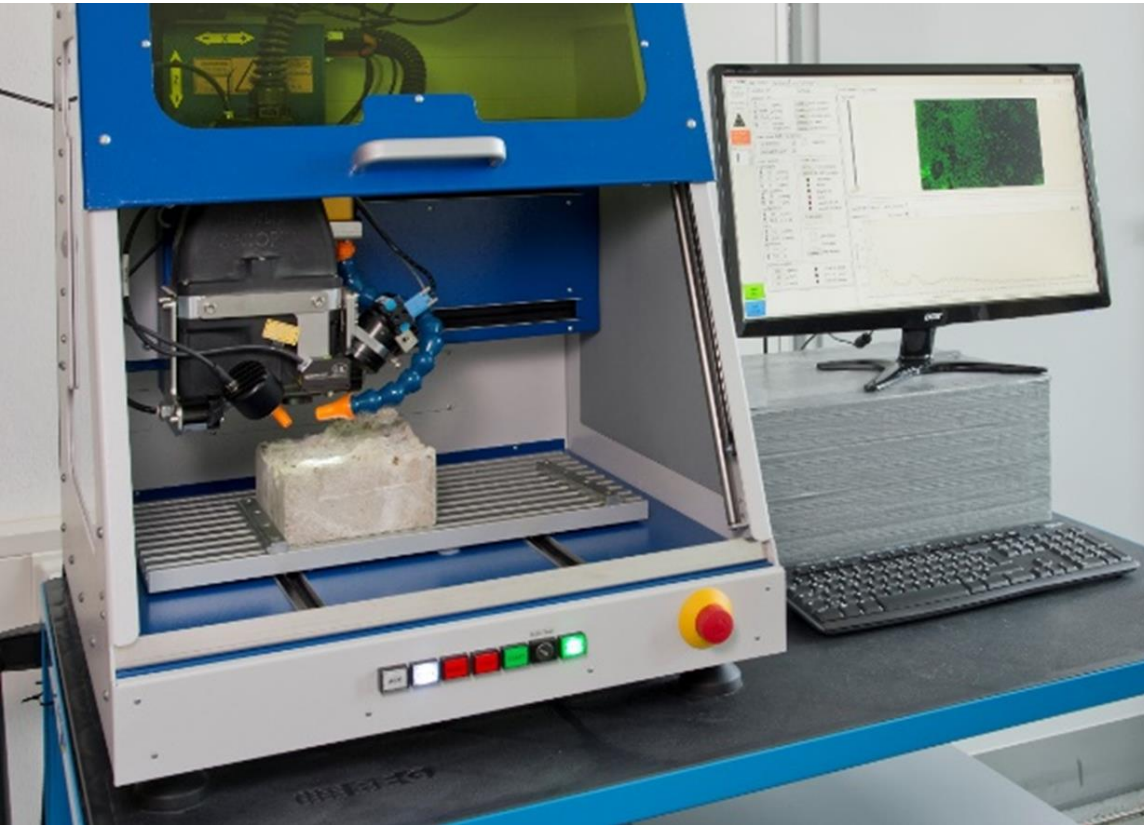


EZ-Anode **active**

EZ-Anode **not active** - Reference Sample



Time of galvanic operation [month]	0	7	12	32,5
24 h off-potential [mV]	-374	-246	-172	*
Charge passed [kC]	0	247	344	450



Element Analysis

by

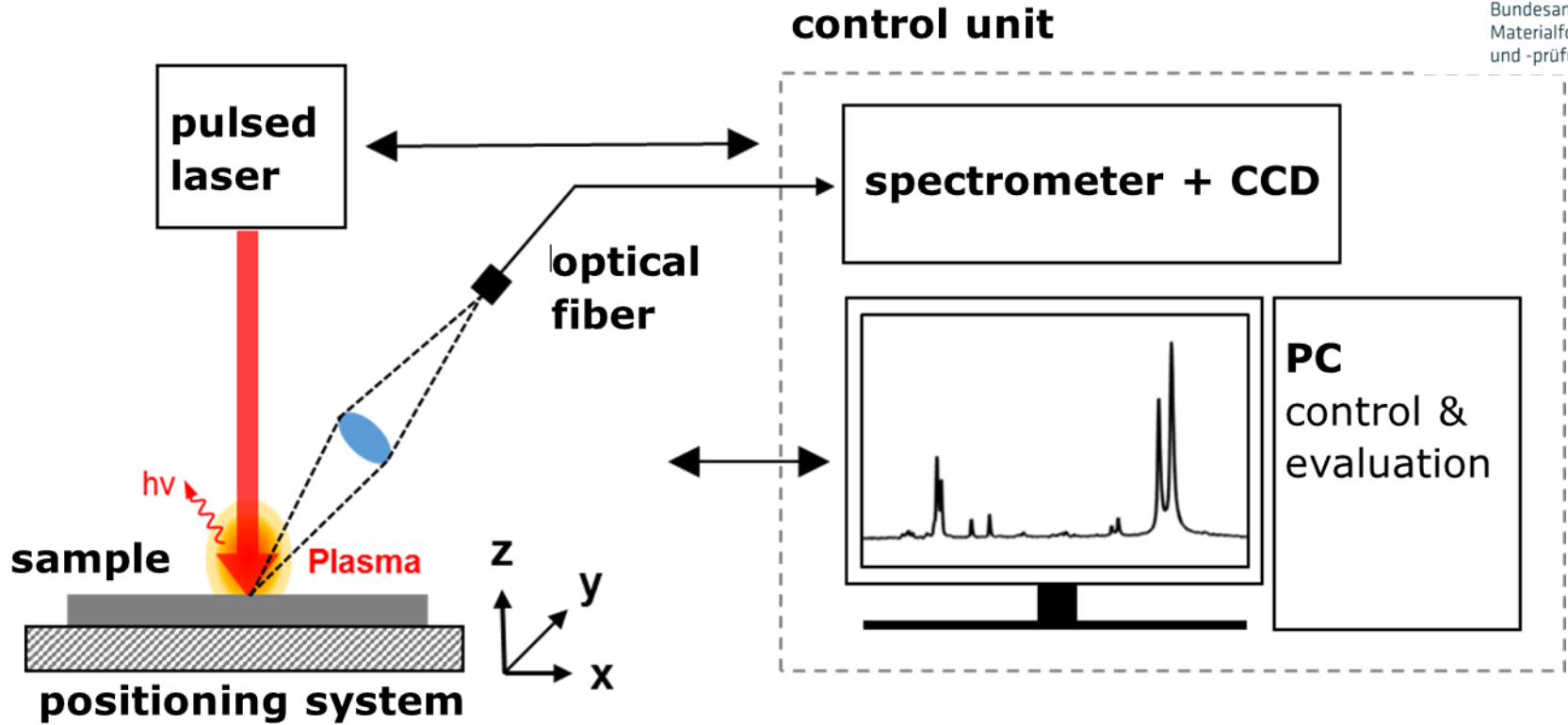
LIBS

Laser Induced Breakdown

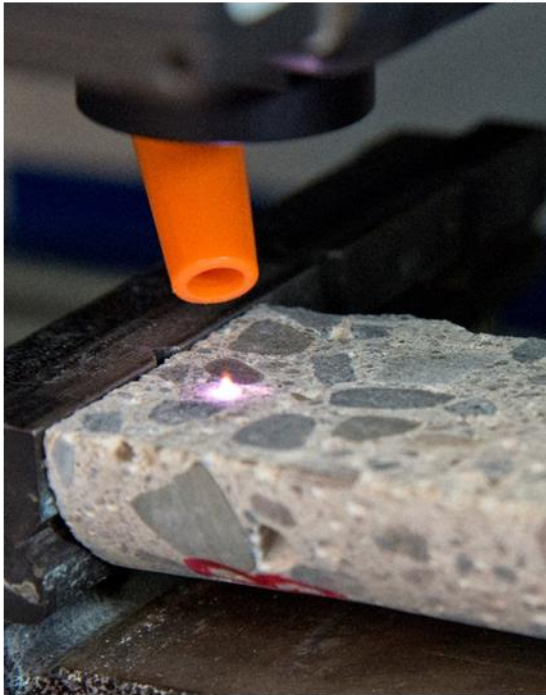
Spectroscopy

at

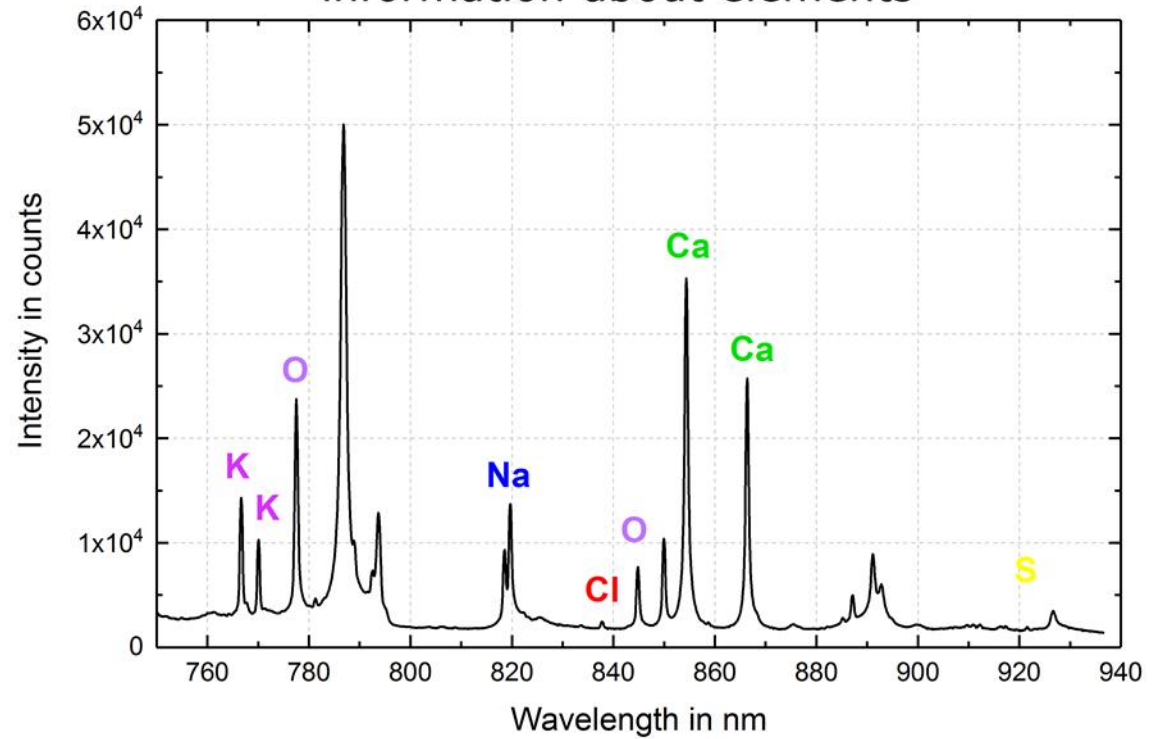




plasma



information about elements

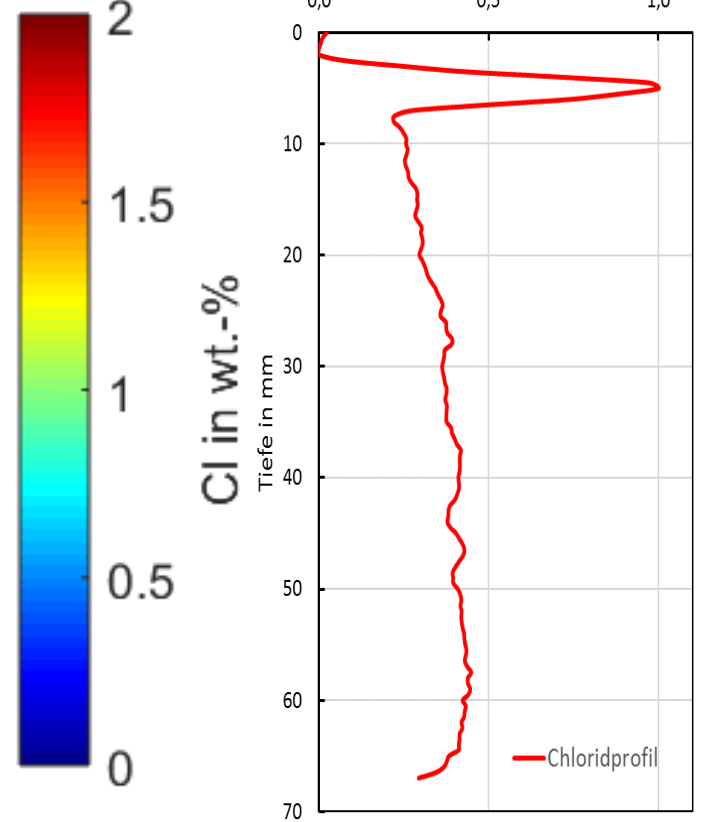
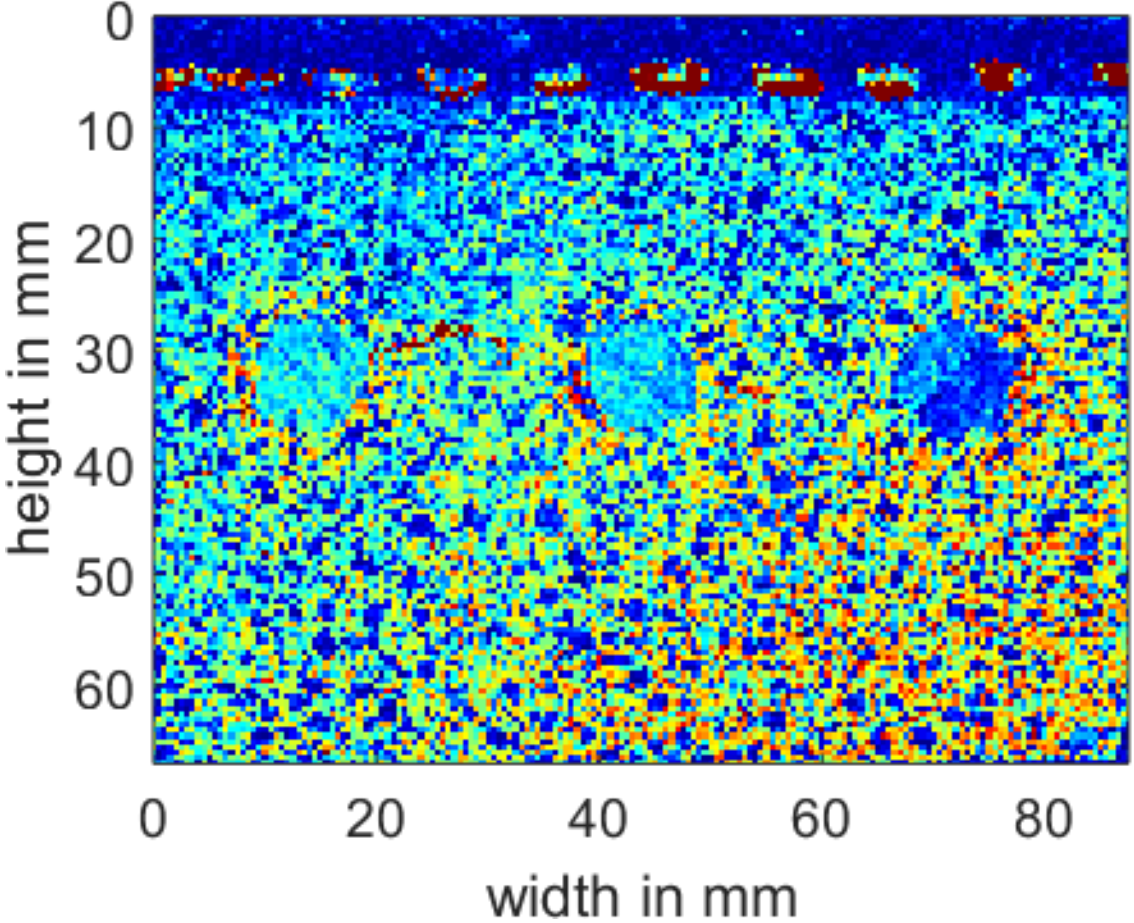


28.08.2019

SMAR 2019, 27. - 29. August 2019

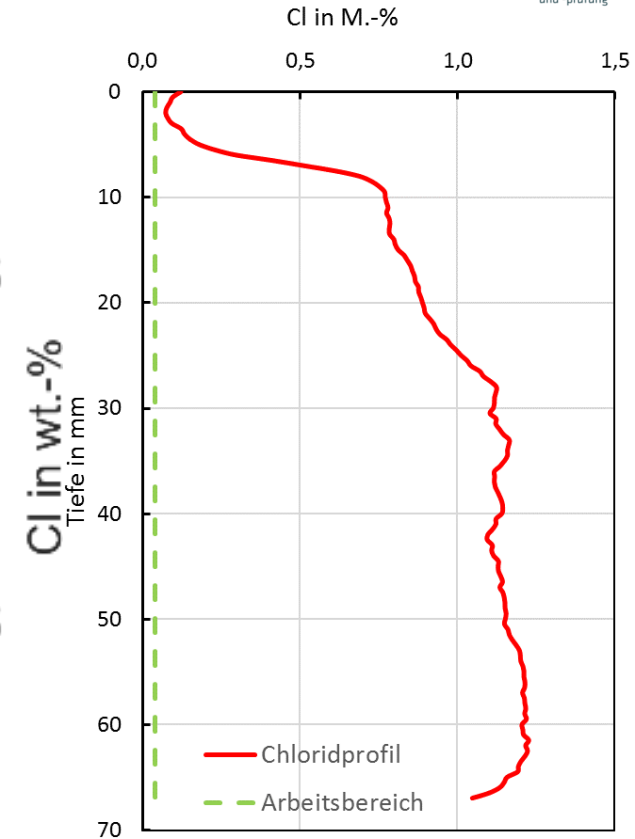
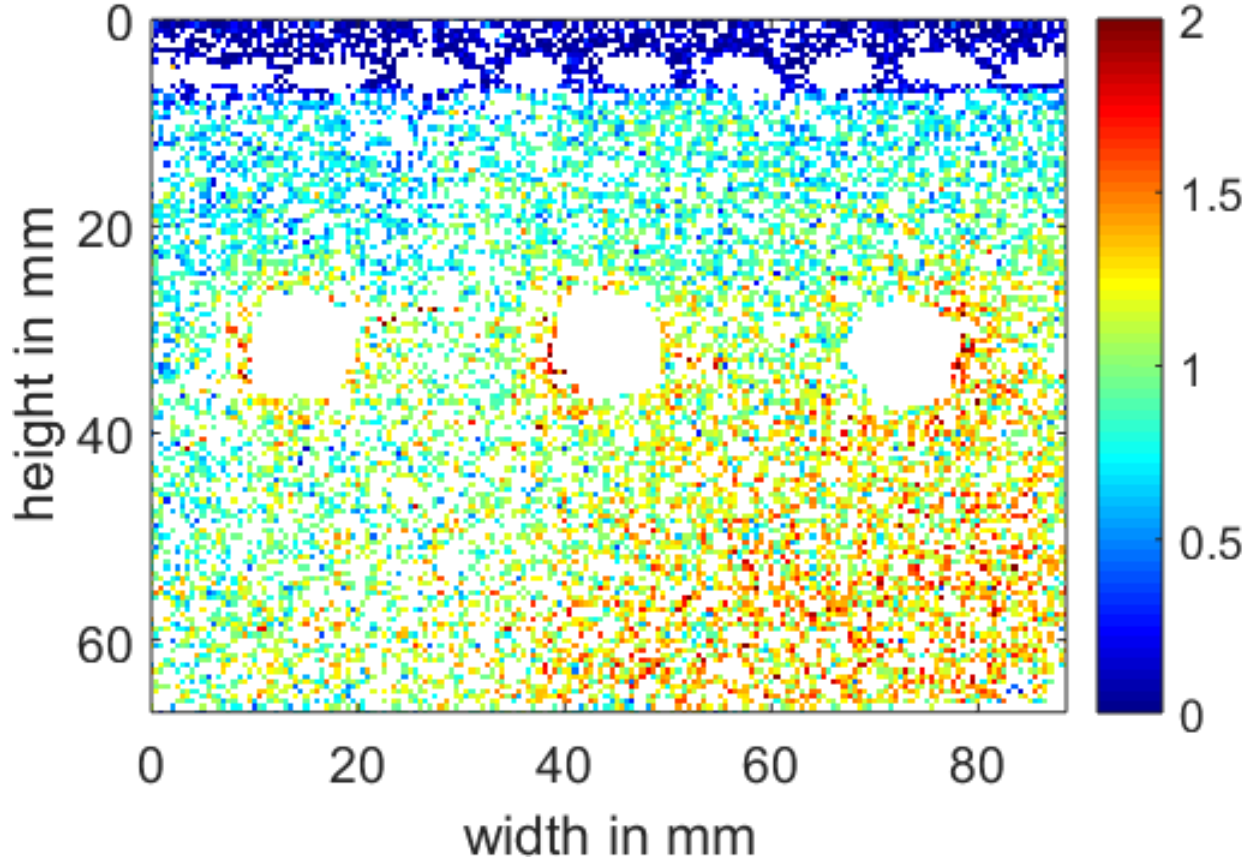
2

Cl (inclusive Agreggate and Zn) after 7 month
Chloride migrates towards anode

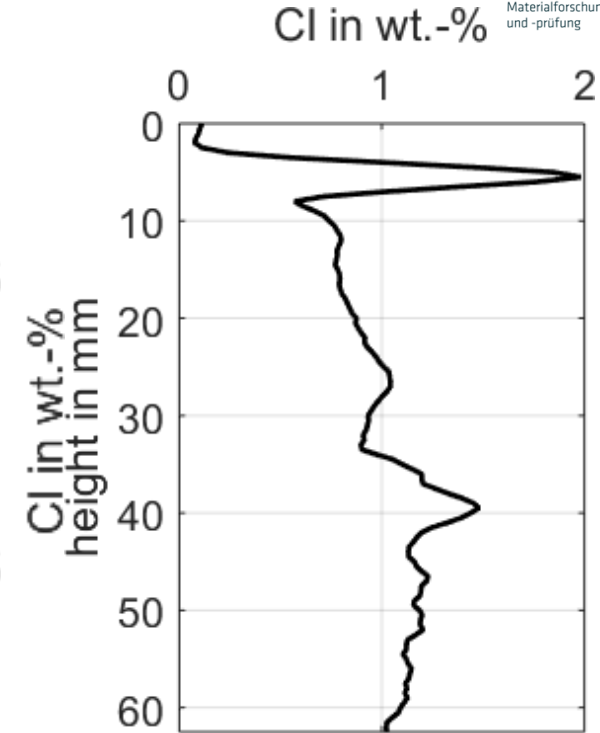
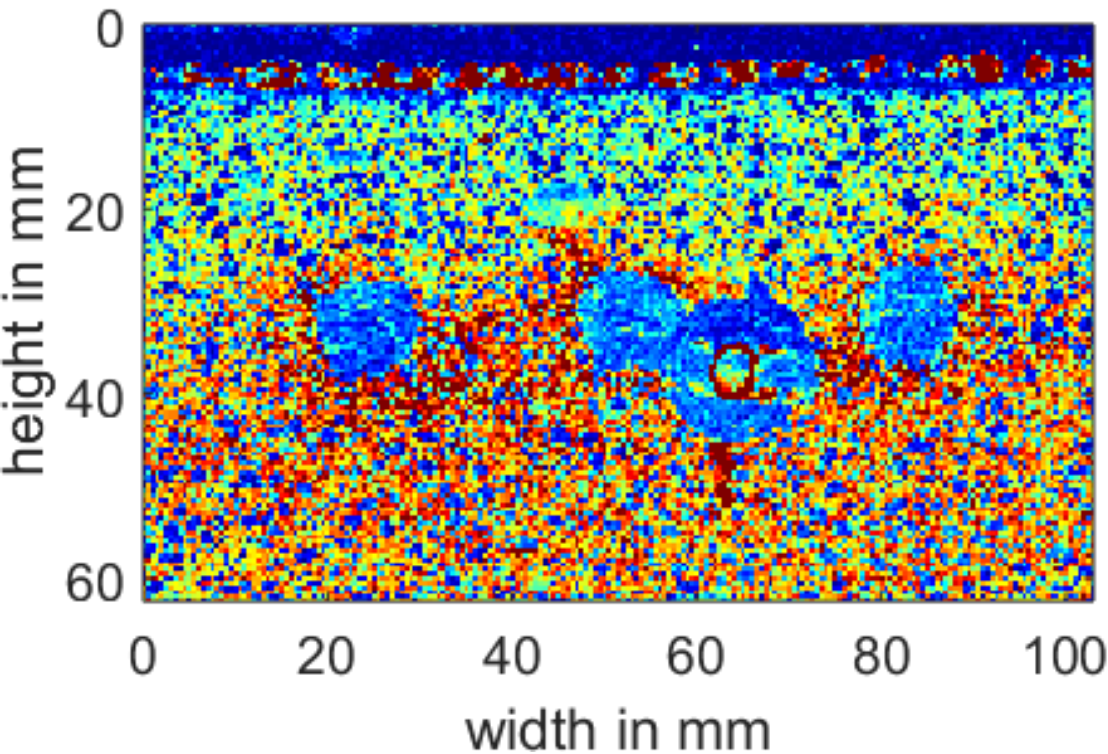


Chlor (aggregate, metallic iron und Zn excluded)
after 7 month

Correlation zinc - chloride

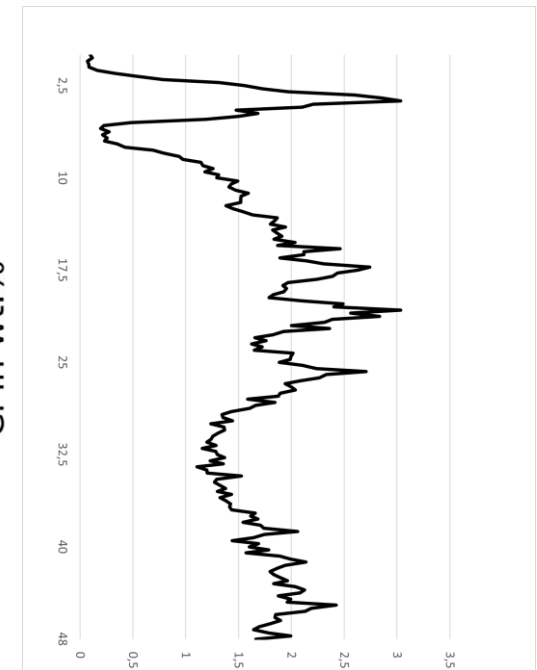
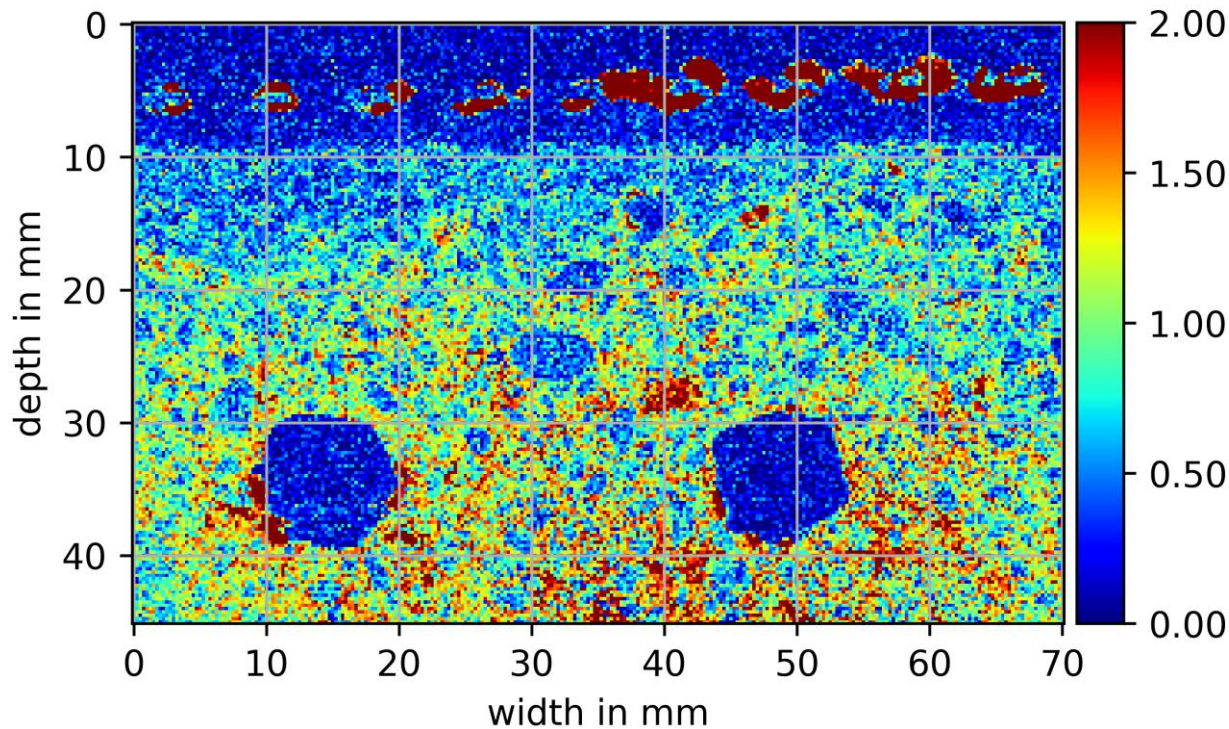


Cl (inclusive Agreggate and Zn) after 12 month
Chloride migrates towards anode

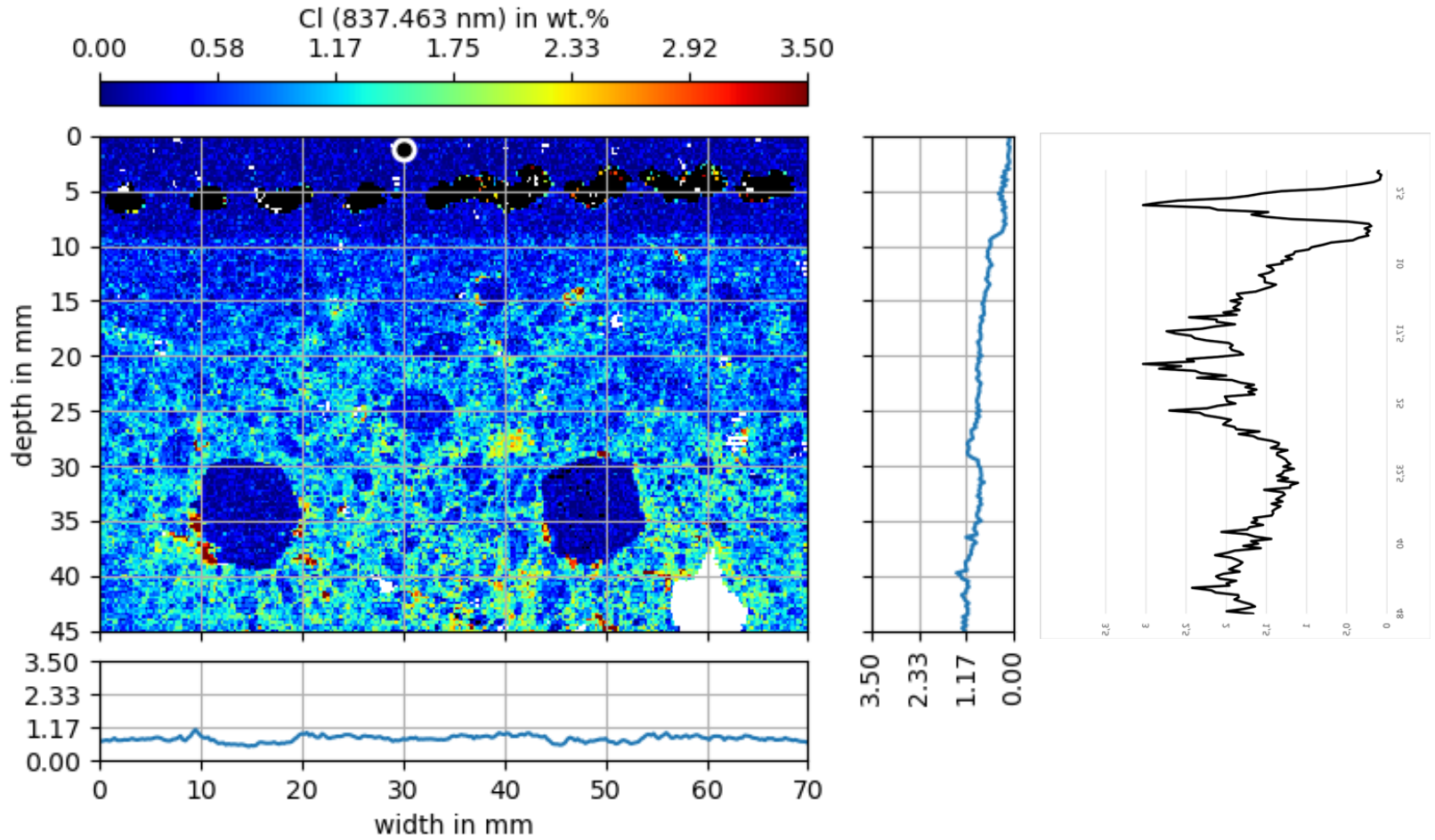


Cl (inclusive Agreggate and Zn) after 30 month

Chloride migrates and diffuses towards anode



Cl (excluded together with Zn) after 30 month

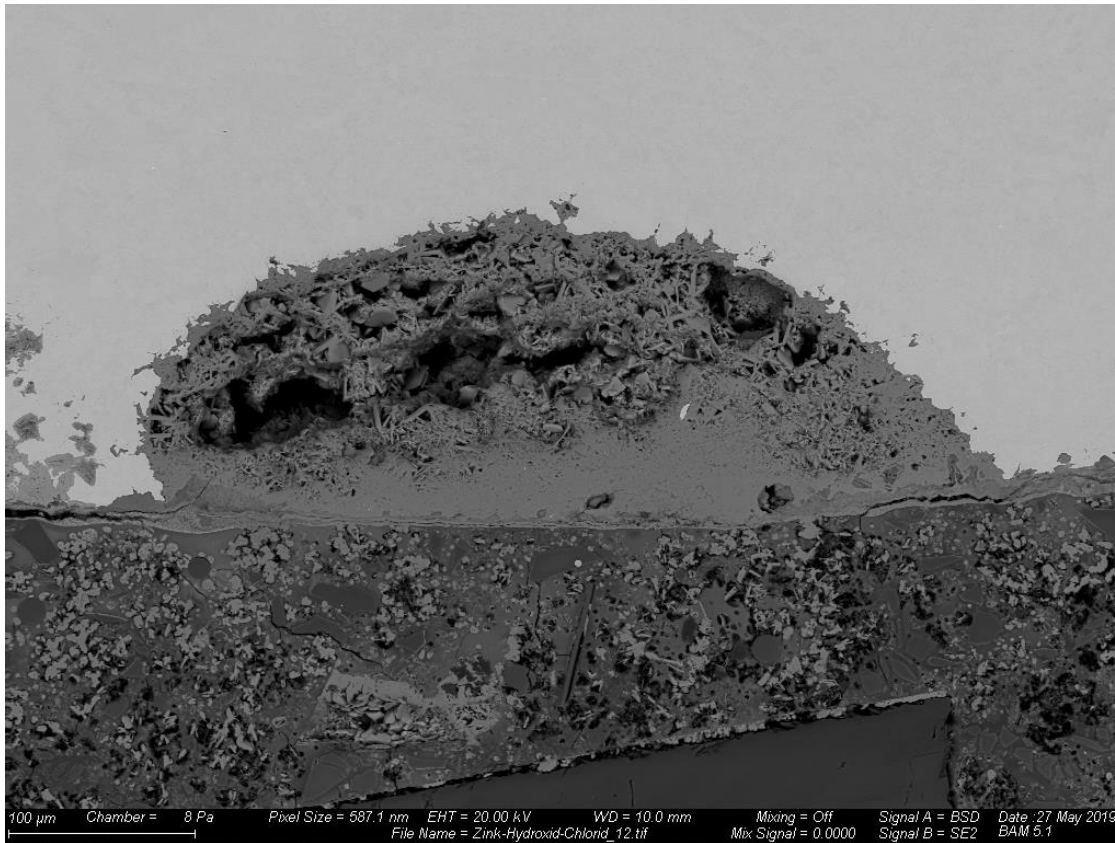


Chloride immobilized as Zinc-Hydroxo-Chloride



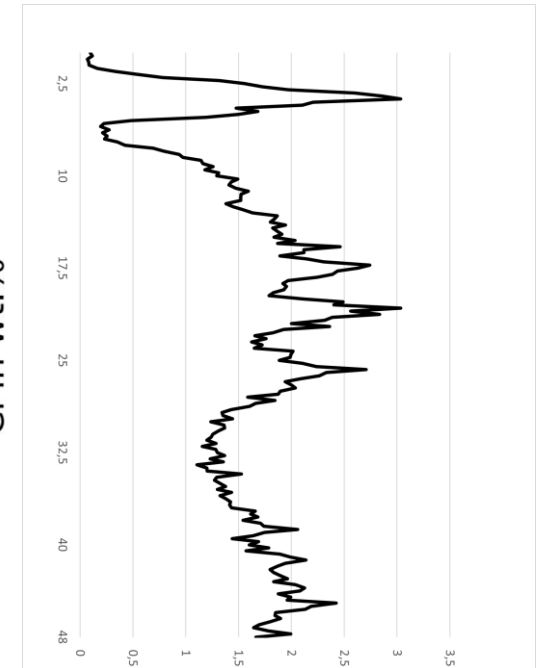
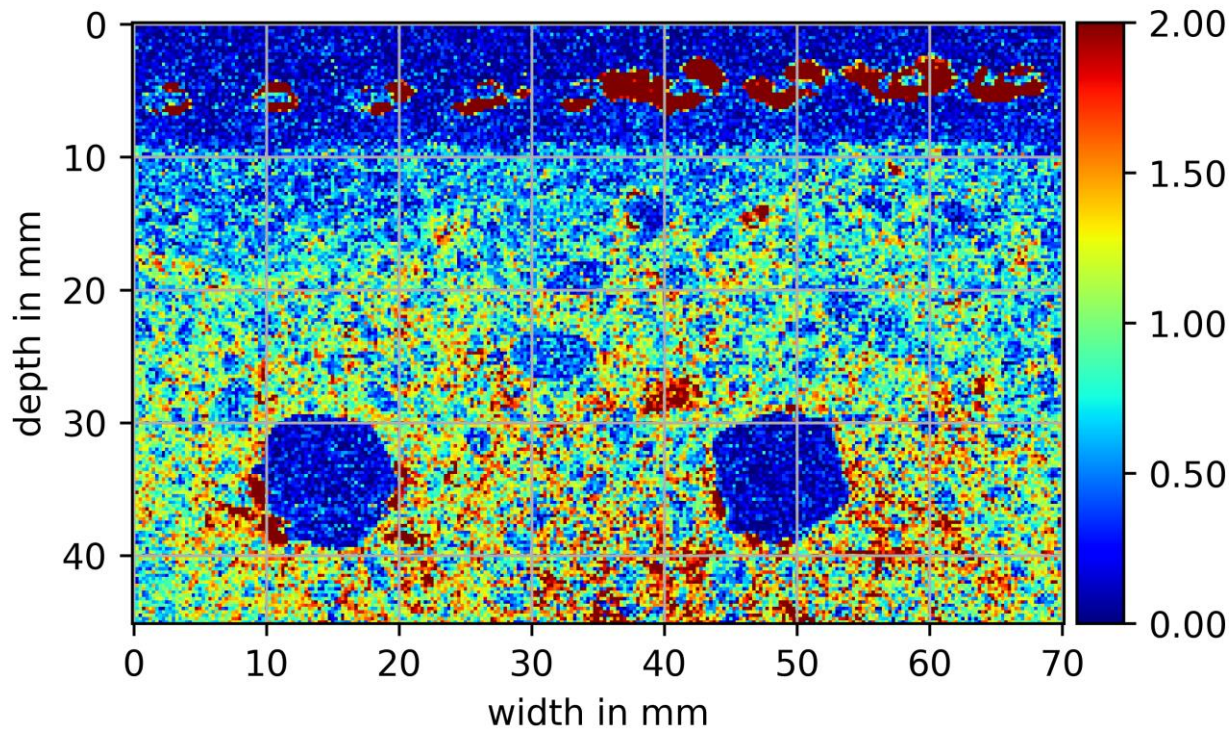
SEM evaluations by Böcker Aletta

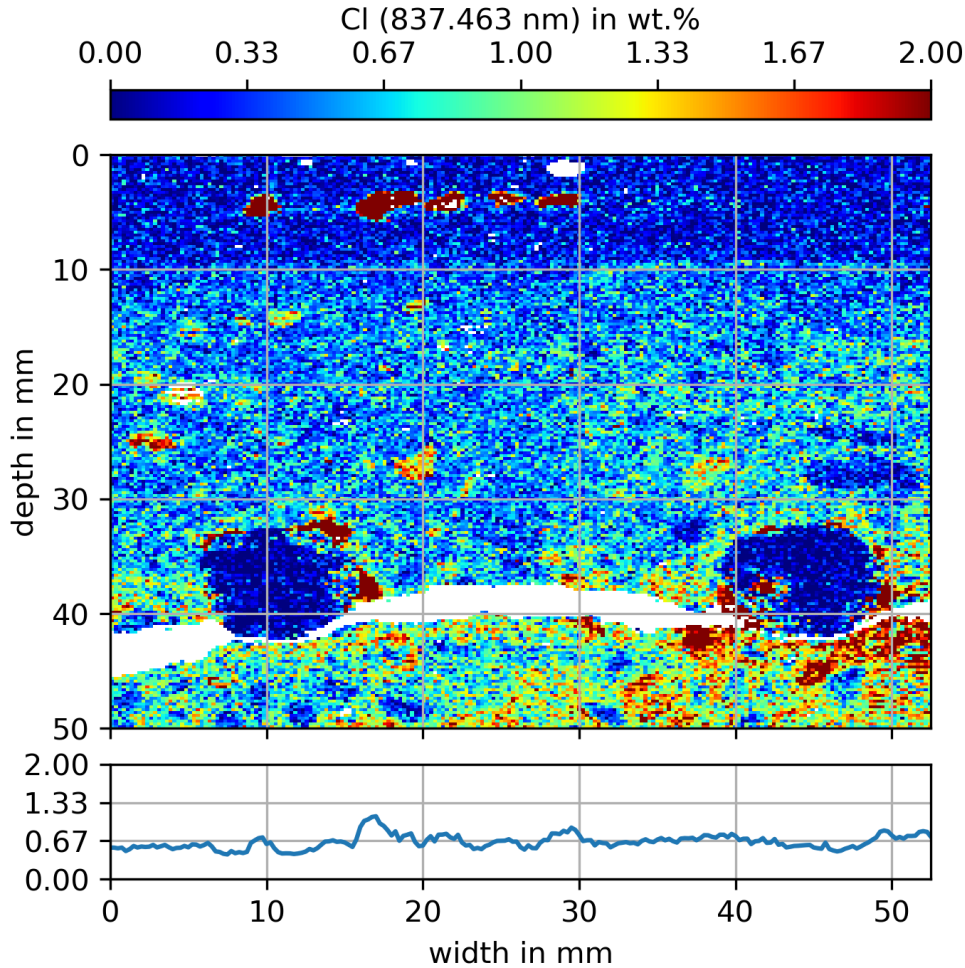
Zinc-Hydroxo-Chloride Mineral Phase Simonkollite



Cl (inclusive Aggregate and Zn) after 30 month

Chloride migrates and diffuses towards anode

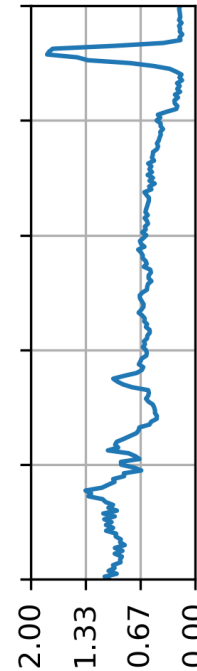


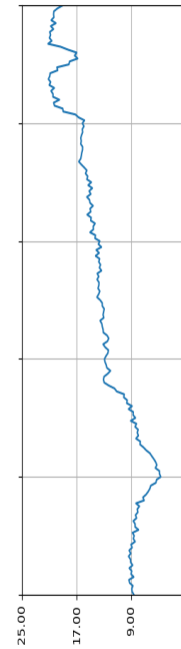
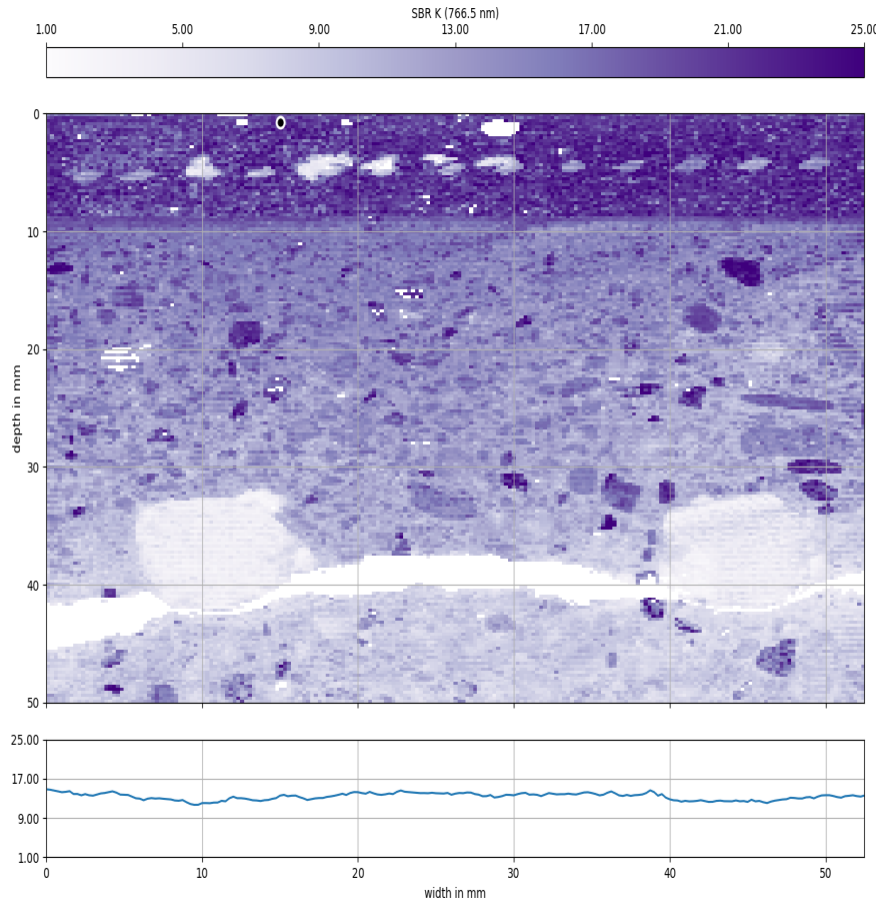


NON ACTIVATED

EZ-ANODE:

Cl (inclusive Aggregate and Zn) after 30 month





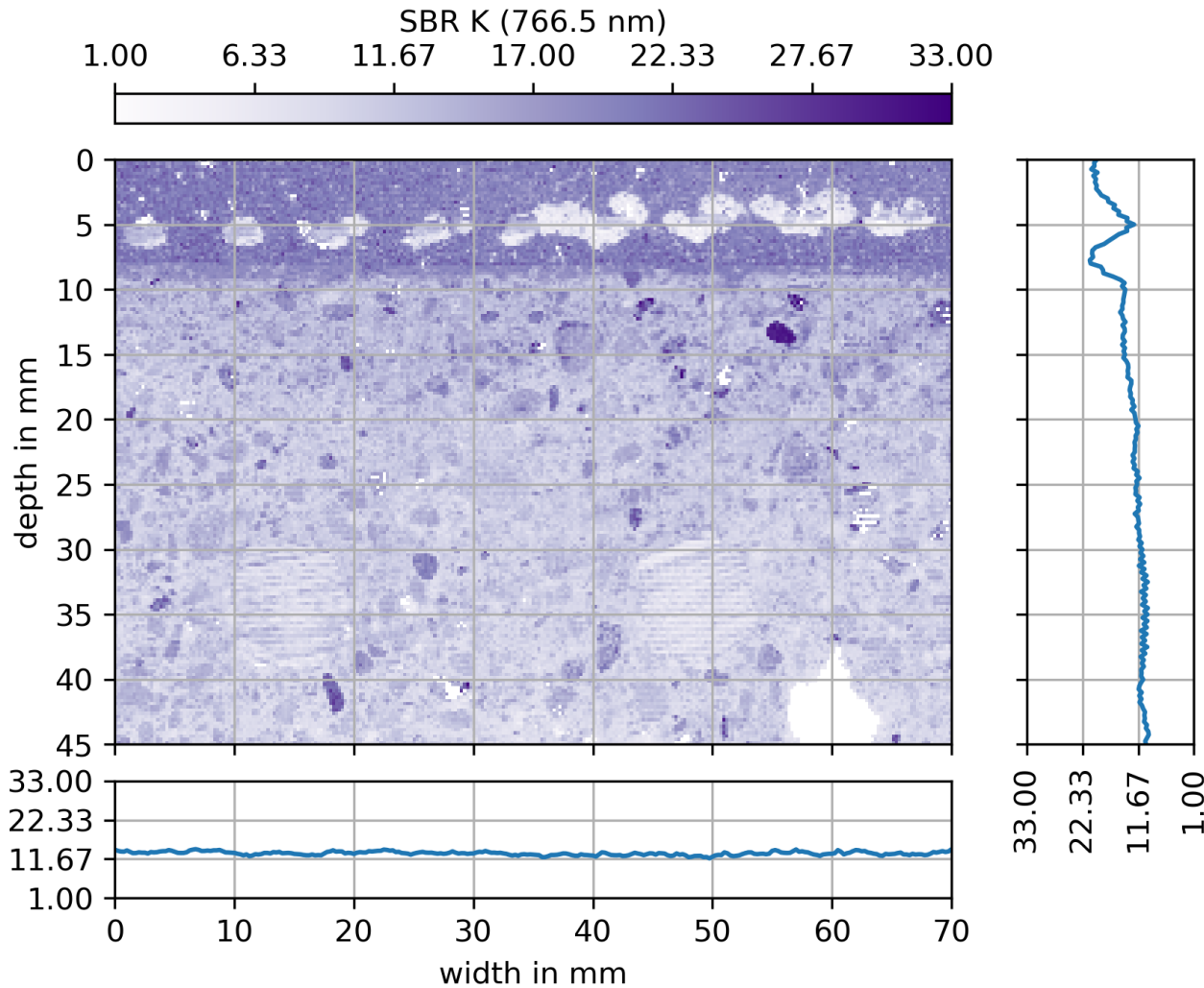
NON ACTIVATED

EZ-ANODE:

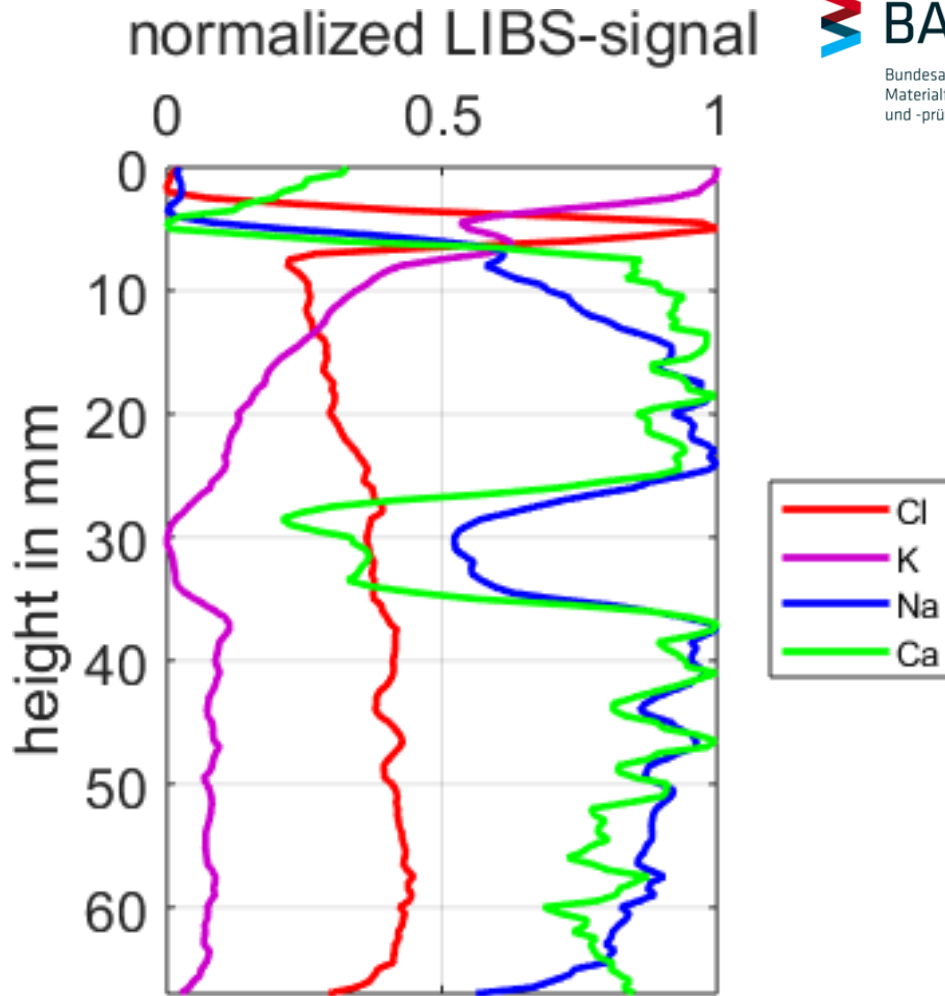
potassium ion

distribution after

30 month



**ACTIVATED
EZ-ANODE:
Potassium ion
distribution after
30 month of
galvanic operation**



ION MIGRATION visualized by LIBS:

- Chloride migrates and accumulates at the anode
- Sodium ions are expelled from the anode
- Potassium, an integral component of the binder migrates towards the steel cathode
- Calcium ion are expelled from the anode

The results indicate that

the chloride is chemically bound in the vicinity of the zinc anode

therefore

impeding back diffusion of chloride into the mortar/concrete matrix

Leading to a high chloride concentration gradient towards the zinc-anode



Diffusion contributes at least 50% to the chloride transport towards the
EZ-anode

The identification of the mineral phases and the chemical composition of the zinc-compounds in which chloride is bound are important and are underway. The results will be reported soon.

The results indicate that

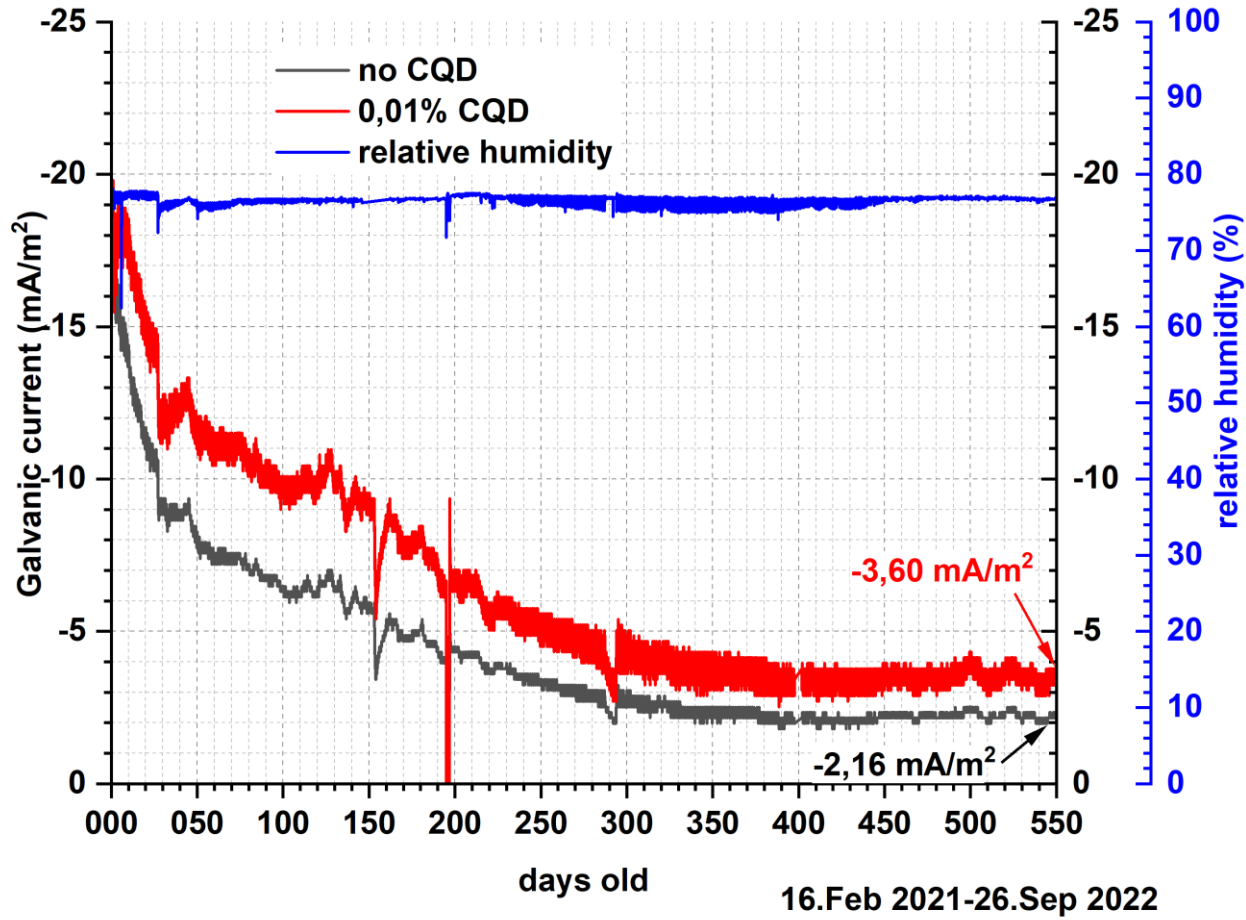
- Significant ion migration occurs in a weak electric field of about 0,2 Volt/cm



The results indicate that

- Significant ion migration occurs in a weak electric field of about 0,2 Volt/cm

Effect of Carbon Quantum Dots (CQD's) on EZ-Anode Galvanic Performance



THANK YOU FOR YOUR ATTENTION

ARE YOU NOW GALVANIZED?