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Wide-range optical pH imaging of cementitious materials exposed to chemically corrosive environments

Supplementary material

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Table A1. Camera settings for t-DLR pH imaging for the three different measurements.

	Evaluation background	Sample measurements	Close-up images
Lens	Pentax TV Lens 12 mm 1:1.2	Pentax TV Lens 12 mm 1:1.2	Schneider Xenoplan 1.4/23-0902
Aperture	16	8	5,6
Integration time	50 ms	90 ms	60 ms
Cycle time	62 µs	62 µs	62 µs
Excitation length	50 µs	50 µs	50 µs
Window length	10 µs	10 µs	10 µs
Delay window 1	40 µs	40 µs	40 µs
Delay window 2	51 µs	51 µs	51 µs

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Table A2. Used buffer substances and their operational pH area

pH range	buffer substance
< 5.75	acetic acid (pKa = 4.76)
5.75 - 6.75	MES (pKa = 6.1)
6.75 - 7.75	phosphate (pKa = 7.21)
7.75 - 9.00	TRIS (pKa = 8.2)
9.00 - 10.00	CHES (pKa = 9.3)
10.00 - 11.50	CAPS (pKa = 10.4)
> 11.50	phosphate (pka= 12.32)

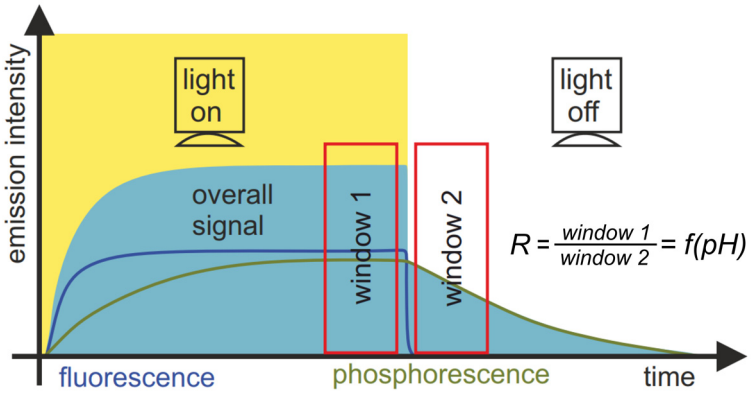

Figure A1. Explanation time-domain dual lifetime referencing (t-DLR); The fluorescence emission of the pH indicator has a short lifetime and is only present in the first window during illumination, whereas the phosphorescence emission of the reference pigment contributes in both windows (modified after [21].)

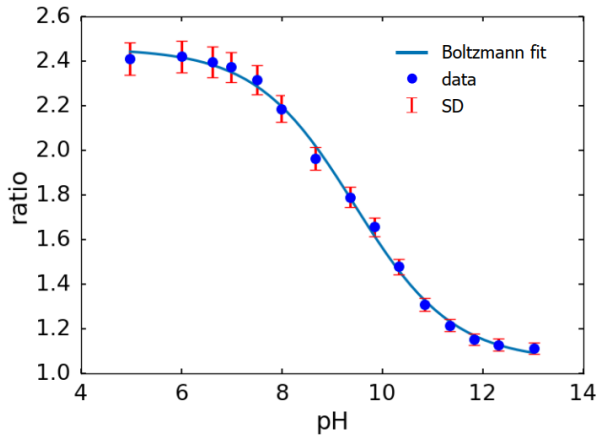

Figure A2. Calibration function, obtained with the macro lens, of the sensor foil combining the indicators m-OH diCl azaBODIPY (pKa= 7.53) and m-OH diF azaBODIPY (pKa= 10.29), which was used for sample measurements. The point of inflection (V_{50}) is at pH 9.45 with a sensitivity (*slope*) of 2.26 pH units per R. The top value (*A*) is 2.46 and the bottom (*B*) value 1.06.

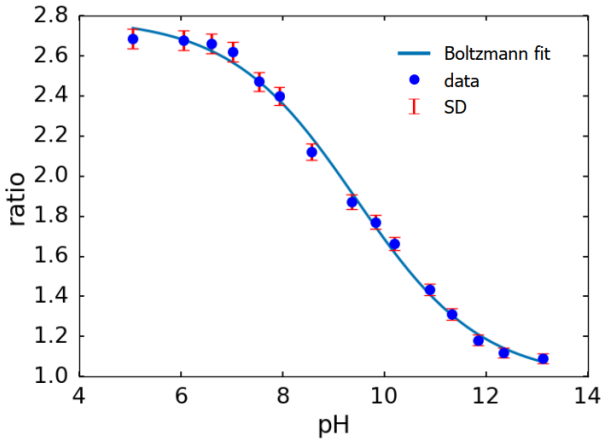

Figure A3. Calibration function, obtained with the standard lens, of the sensor foil combining the indicators m-OH diCl azaBODIPY (pKa= 7.53) and m-OH Cl azaBODIPY (pKa= 10.77), which was used for background evaluation. The point of inflection (V_{50}) is at pH 9.44 with a sensitivity (*slope*) of 2.97 pH units per R. The top value (*A*) is 2.80 and the bottom (*B*) value 0.97.

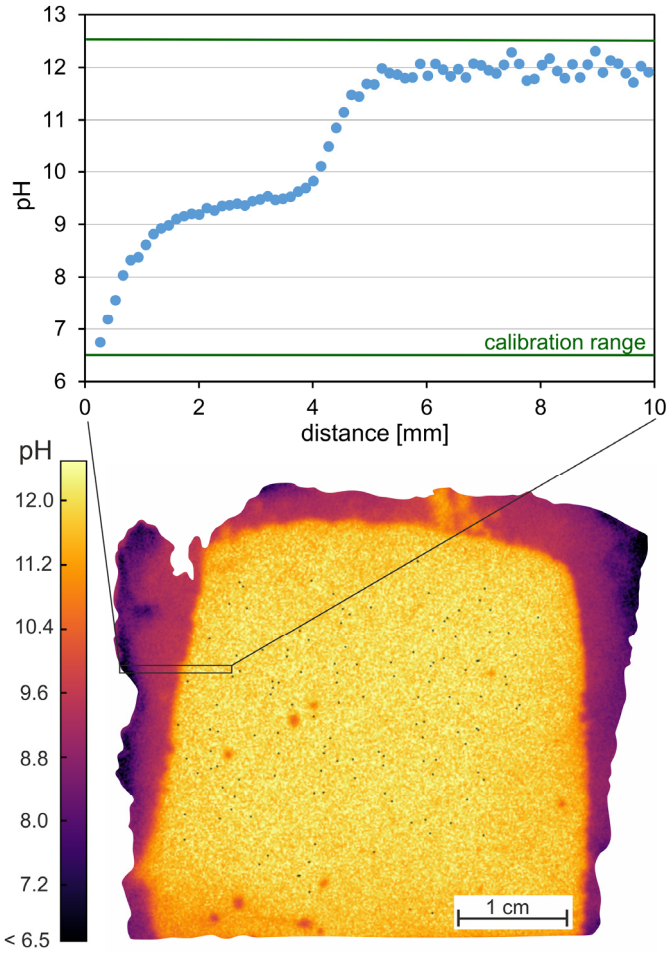

Figure A4. Cross-section of a UHPFRC sample after 12 months of exposure to biogenic acid attack. False color pH image of the sample with the pH gradient displayed for the first 10 mm.