Optical sensing of pH in oil well cement

Nielsen, Søren Dollerup; Paegle, Ieva; Borisov, Sergey M.; Kjeldsen, Kasper Urup; Røy, Hans; Skibsted, Jørgen; Koren, Klaus

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Optical sensing of pH in oil well cement

Søren Dollerup Nielsen (1), Ieva Paegle (2), Sergey M. Borisov (3), Kasper Urup Kjeldsen (1), Hans Røy (1), Jørgen Skibsted (4), Klaus Koren (5)

(1) Center for Geomicrobiology, Section for Microbiology, Department of Bioscience, Aarhus University, Aarhus, Denmark
(2) Department of Civil Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark
(3) Institute of Analytical Chemistry and Food Chemistry, Graz University of Technology, Graz, Austria
(4) Department of Chemistry and Interdisciplinary Nanoscience Center (iNANO), Aarhus University, Aarhus, Denmark

Presenting author: Søren Dollerup Nielsen
Is the presenting author a research assistant/MSc/PhD student/Postdoc? Postdoc

Programme your research belongs to: CTR2, Improved Cement Material Meeting

Abstract text
The Self-healing cement project aims to apply a microbially-engineered system for calcium carbonate precipitation in deep sub-seafloor environments to fix cracks formed in cement structures around oil wells and boreholes. The cement matrix however imposes a harsh alkaline environment for bacterial activity to facilitate the precipitation needed for crack healing. An important parameter determining the biocompatibility of concretes and cements is therefore the pH environment. We have implemented the use of a planar optode system that enables high spatial resolution measurements of pH around and in side submillimeter cracks in hydrated oil well cements. Specifically, the optode can image pH with a spatial distribution of 50 μm per pixel and a gradient of 1.4 pH units per 1 mm. The effect of fly ash substitution and hydration time on the pH of the cement surface was evaluated by this approach. The results showed that pH is significantly reduced from pH > 11 to below 10 with increasing fly ash content as well as hydration time. Hereby the cement becomes compatible with microbial activity, which we experimentally validated by embedding bacteria into the cement and monitoring their metabolic activity. In conclusion, our results demonstrate that the pH of class G cements can reliably be measured and modified to sustain microbial activity.