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Bjørgård, Trine Larsen; Margheritini, Lucia; Simonsen, Morten Enggrob

Publication date:
2018

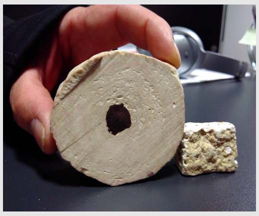
Development of new a material for sea water substructures by seawater electrolysis

Trine L. Bjørgård[1], Lucia Margheritini[2], Morten E. Simonsen[1]
[1]Aalborg University, Department of Chemistry and Bioscience, Esbjerg, Denmark. tlb@bio.aau.dk; mes@bio.aau.dk
[2] Aalborg University, Department of Civil Engineering, Aalborg, Denmark

01 INTRODUCTION

A NEW, INNOVATIVE MATERIAL

The aim of this study is to investigate the applicability of a material made by seawater electrolysis as a subsea **construction material** for green offshore energy structures.



02 BACKGROUND

ELECTROLYSIS OF SEAWATER

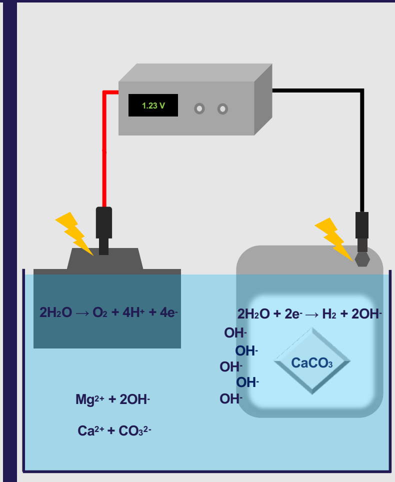
The process is based on **electrolysis** of seawater. When immersing a pair of electrodes in seawater and applying a relatively small electric voltage, the water molecules close to the electrodes will be split into hydrogen and oxygen according to the following equations [1]:

Anode reaction $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

Cathode reaction $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

MINERAL ACCRETION

Among the ions dissolved in seawater calcium ions (**Ca^{2+}**) and carbonate ions (**CO_3^{2-}**) are of interest for mineral accretion by seawater electrolysis. Calcium carbonate (**$CaCO_3$**) form two polymorphs in seawater, **aragonite** or **calcite** depending on factors like temperature and ion concentrations. At relatively high voltages a softer material, magnesium hydroxide (**$Mg(OH)_2$**, **brucite**) can precipitate [2].



03 RESULTS

ELECTRODE MATERIALS

The environment in the close vicinity of the anode is highly **acidic** and makes the conditions unsuitable for many materials. Two types of inert materials has been chosen for laboratory and field testing, dimensionally stable anode (**DSA**) and platinum covered titanium anode (**Pt-Ti**).

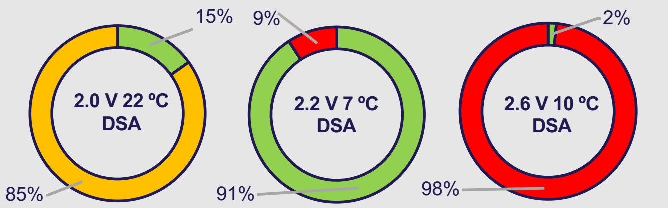
APPLIED POTENTIAL

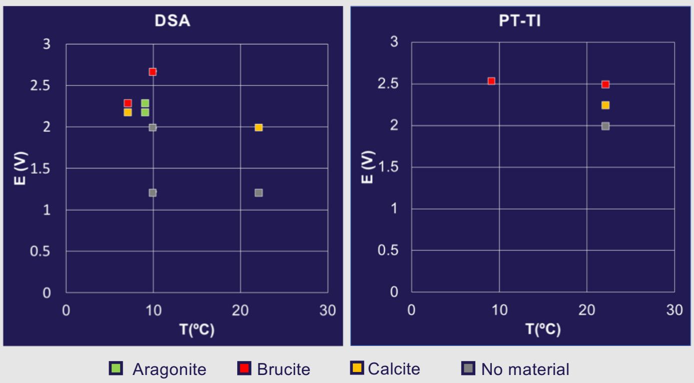
Using **Nernst equation** in combination with the **Tafel equation** the minimum potential for mineral deposition have **experimentally** been determined for DSA and Pt-Ti anodes in combination with **stainless steel cathodes** at ambient temperature.

Minimum potential for deposition

DSA 1.831 V
Pt-Ti 2.046 V

MATERIAL COMPOSITION





VOLTAGE INTERVAL FOR CALCIUM CARBONATE DEPOSITION

An initial voltage interval for **electrodeposited** material has been established experimentally, indicating that only a **narrow range** of voltage will result in deposition of $CaCO_3$.

DEPOSITION OF BRUCITE

Experiments indicates that 2.5 V is the upper voltage limit for $CaCO_3$ deposition, exceeding this level results in deposition of **brucite**

EFFECT OF TEMPERATURE

This study indicates that lower water temperatures requires higher applied potential for material deposition. One of the main aspects of this study is the applicability of the method in the **North sea**. The preliminary results of this study indicates the possibility of applicability of the method on cold seawater.

04 CONCLUSION

- The composition of the deposited material depend highly on the **applied potential**, the **electrode material** and the **temperature** of the seawater
- The **lowest** possible applied **potential** results in the material with the **highest** amount of **aragonite**, but at the expense of **growth rate**
- Preliminary results indicates that employment of method in **cold water** is possible

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8th European Summer School On Electrochemical Engineering

8essee2018.sciencesconf.org