

## DEVELOPMENT OF A BIODEGRADABLE NATURAL POLYMER/CERAMIC COATING FOR MG ALLOYS USING ELECTROPHORETIC DEPOSITION

S. Heise, Institute for Biomaterials, University of Erlangen-Nuremberg, Germany  
svenja.heise@fau.de

T. Wirth, Institute for Biomaterials, University of Erlangen-Nuremberg, Germany  
M. Hoehlinger, Chair for Surface Science and Corrosion, University of Erlangen-Nuremberg, Germany  
V. Wagener, Chair for Surface Science and Corrosion, University of Erlangen-Nuremberg, Germany  
H. Hornberger, Institute of Biomaterials, Regensburg University of Applied Sciences, Germany  
S. Virtanen, Chair for Surface Science and Corrosion, University of Erlangen-Nuremberg, Germany  
A.R. Boccaccini, Institute for Biomaterials, University of Erlangen-Nuremberg, Germany

Magnesium and its alloys have already been proposed for biomedical applications in 1878. However, up to date no extended, successful medical Mg product is commercially available. The drawbacks of permanent implants, like stress-shielding or possible release of metal ions through wear, can be avoided with the use of biodegradable metals. Temporary implants as such could make a second surgical process to remove the implant unnecessary, not only decreasing the healthcare costs and associated risks of a surgery, but also reducing the trauma to the patient.

Mg is an abundant cation in the human body and in part physiologically beneficial as the surrounding tissue can absorb and consume the ions. The main problems related to the usage of Mg and its alloys is its high chemical reactivity, a related low corrosion resistance, especially in chloride-containing environments and the accompanying fast hydrogen gas production. [1]

In order to overcome these problems in this study a coating of a natural polymer/bioactive glass composite is applied using electrophoretic deposition. Additionally, functional properties like drug delivery characteristics and antibacterial capacity are added to these coatings.

As natural, cationic polymer chitosan is taken which is the supporting material in the exoskeleton of crustaceans and insects (crab, butterfly) and in cell walls of fungi. It combines biodegradability and biocompatibility with the ability to promote cell adhesion. [1]

To avoid dissolution of the Mg alloy substrate during the deposition, a pretreatment is used. The immersion in DMEM for 24 h is increasing the corrosion resistance to a level that the acidic, aqueous electrolyte during deposition is not corroding the Mg substrate. [2] A comparative study was performed on replacing part of the bioactive glass as ceramic part with silica particles in order to maintain a topography during dissolution of the glass. A constant solid content of 1 g/l was chosen, with 0.5 g/l chitosan in 1 vol% acetic acid, 20 vol% water and 79 vol% ethanol following previous studies. [3] For the cathodic deposition process 0.5 cm electrode distance with stainless steel as the counter electrode was used. The deposition was performed under constant current (50 V) and constant voltage (35 mA) with varying processing times.

[1] Heise S, Virtanen S, Boccaccini AR. 2016. Tackling Mg alloy corrosion by natural polymer coatings—A review. *J Biomed Mater Res Part A* 2016;104A:2628–2641

[2] Wagener V, Virtanen S. 2016 Protective layer formation on magnesium in cell culture medium. *Mater. Sci. Eng. C* 63, 341–351

[3] Cordero-Arias, L. et al. 2013 Electrophoretic deposition of nanostructured-TiO<sub>2</sub>/Chitosan composite coatings on stainless steel. *R. Soc. Chem.* 3, 11247-11254

Acknowledgements: This study is supported by the German Science Foundation (DFG).