6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 15 June 2018, Glasgow, UK

CHEMOELECTROMECHANICAL COUPLING ON INTERFACES IN NANOCOMPOSITE ACTUATORS

Jana Wilmers[1], Andrew McBride[2] and Swantje Bargmann[1]

[1] Chair of Solid Mechanics, University of Wuppertal, Germany
[2] School of Engineering, The University of Glasgow, United Kingdom

Key words: *Interface Elasticity, Multiphysics Problems, Nanocomposites*

Electromechanical coupling in actuators and sensors arises from various physical processes in the material, e.g., charge re-orientation or surface modification. Depending on the material system at hand, different mechanisms are activated and superimposed. Nanoporous metals have recently garnered interest as the base material for nanocomposite actuators as they can be functionalised by impregnation of the interconnected pore space with a ionic conductor, such as an aqueous electrolyte or a ionically activated polymer. These hybrid actuators react sensitively to the application of electric signals due to their high interface-to-volume ratio, which makes them promising candidates for a wide range of possible applications.

To model the chemoelectromechanically coupled behaviour of such nanoporous actuators, one has to account for interface modifications arising from the build-up of charges in the metal-electrolyte interface and electroadsorption of electrolyte ions onto the interface. In this work [1], a continuum model is utilized that couples large deformations with electrostatics and charge carrier transport to model the bulk behaviour. This framework is further extended using the principles od surface elasticity theory [2] to establish a model for the unique electromechanical behaviour of the metal-electrolyte interface. The developed framework utilises the concept of interface stresses to model the different coupling mechanisms occurring on the interface, that is, interface charging and electroadsorption, in addition to the coupled behaviour in the bulk material arising from mass transport in the pore space. The framework allows to study the different phenomena and their interaction with each other and gives insights into the underlying physical mechanisms. Numerical examples are presented to elucidate the capabilities of the proposed model.

REFERENCES

[1] J. Wilmers, A.T. McBride and S. Bargmann, Interface Elasticity Effects in Polymer- Filled Nanoporous Metals, *J. Mech. Phys. Solids* (2017) **99**, pp. 163-177.

[2] A.T. McBride, A. Javili, P. Steinmann and S. Bargmann, Geometrically nonlinear continuum thermomechanics with surface energies coupled to diffusion, *J. Mech. Phys. Solids* (2011) **59**, pp. 2116-2133.

[3] L. Lührs, C. Soyarslan, J. Markmann, S. Bargmann and J. Weissmüller, Elastic and plastic Poissons ratios of nanoporous gold, *Scr. Mater.* (2016) **110**, pp. 65-69.