New experimental and modelling approaches to understand electrodeposition of metals

Terryn H*

[1] *Research Group Electrochemical and Surface Engineering-SURF*
Department of Materials and Chemistry
Pleinlaan 2, 1050 Brussels, Belgium
Herman.terryn@vub.be

Recently our research has been focused on understanding better the link between metal microstructure and electrochemistry. While the first part of the talk is on the electron nucleation of particles and related metal microstructural effects, the second parts discusses the electrochemical properties as function of the metal microstructure.

1) Metal nanocrystals are of great interest due to their unique properties that can be tuned by adjusting their size and shape. When supported on different substrates, they find applications in different fields, such as catalysis or sensing. Electrochemical deposition allows the growth of the nanostructures in one step, directly on the final support. Hence, it has been proven effective to obtain highly electroactive nanostructures with potential for fuel cell or (bio)sensing applications. One of the key issues to benefit from the properties of supported nanostructures is to understand their formation mechanisms to achieve a good control of their morphology. However, the early stages of electrochemical nucleation and growth are still an active field of research and remain unraveled. Although the classical theory predicts that nanocrystals grow irreversibly by atomic addition until the reaction is halted, we have found proof that alternative growth mechanisms are taking place [1]. In our work, we combine Field Emission Scanning Electron Microscopy (FESEM), aberration-corrected Transmission Electron Microscopy (TEM), electron tomography, in-situ Small Angle X-ray Scattering (SAXS) and electrochemical characterization to study the early stages of metal electrodeposition onto carbon substrates from aqueous solutions and Deep Eutectic Solvents (DESs) [2]. As evidenced from an innovative experimental approach, we have identified some key processes that influence the early growth mechanisms and microstructure of metals electrodeposited on carbon substrates.

2) When aiming for an increased and more sustainable use of metals a thorough knowledge of the corrosion phenomenon as function of the local metal microstructure is of crucial importance. In this work, we bring together the information presented in our last publications on pure Cu [3-5] to present an overview of the different local (electrochemical) techniques that proved to be efficient to study the relation between different microstructural variables and their different electrochemical behavior. The Atomic force microscopy (AFM) [3], Scanning electrochemical microscopy (SECM) [4] and Electrochemical scanning tunneling microscopy (EC-STM) [5] were used in combination with Electron backscatter diffraction (EBSD), consequently, correlations between grain orientation and grain boundary characteristics, on the one hand, and the electrochemical behavior on the other hand, could be identified.

[1] Ustarroz J., Hammons J., Altantzis T., Hubin A., Bals S., Terryn H. J. of the Am. Chem.Soc, **135**, 31, (2013)11550.
[2] Ustarroz J., Atlantzis T., Hammons J., Hubin A., Bals S., Terryn H. Chem of Mat, **26**, 7, (2014)2396.
[3] L. Lapeire, E. Martinez Lombardia, K. Verbeken, I. De Graeve, L. Kestens, H. Terryn, Corrosion Science 67 (2012) 179-183.
[4] E. Martinez-Lombardia, Y. Gonzalez-Garcia, L. Lapeire, I. De Graeve, K. Verbeken, L. Kestens, J. Mol, H. Terryn Electrochimica Acta 116 (2014) 89-96
[5] E. Martinez-Lombardia, L. Lapeire, V. Maurice, I. D. Graeve, K. Verbeken, L. Klein, L. Kestens, P. Marcus, H. Terryn, Electrochemistry Communications 41 (0) (2014) 1-4