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## Introduction

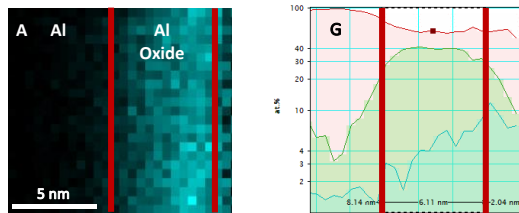
Because of its electro chemical properties, aluminium is seen as a possible active material for future rechargeable batteries. In this work, a deep eutectic solvent (DES) consisting of  $\text{AlCl}_3$  and urea was used.

In many environments, aluminium is protected from corrosion by its native oxide layer, which makes it an attractive construction material. In the context of electrochemical cells, this is a limitation. Aggressive anion containing media (e.g. Cl) can cause the breakdown of the passive oxide and lead to corrosion. From literature it is well known, that in aqueous media chloride anions permeate the passive layer before pitting.

Literature on aluminum in combination with chloroaluminate IL or DES suggests, that contact between electrode and electrolyte before electrochemical experiments, can improve the cell performance. However, the underlying mechanism is not known. This work will provide further insights on processes occurring during this soaking time.

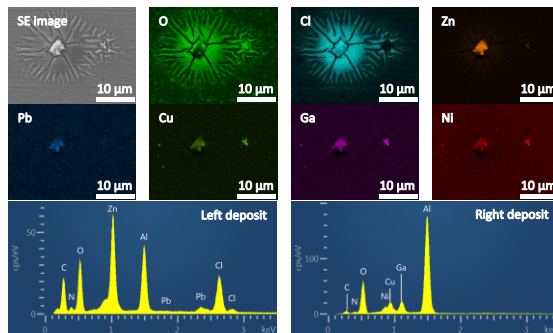
## Transmission Electron Microscopy (TEM)

TEM provides the opportunity of elemental and chemical mapping at high resolution. After soaking, a Cl gradient was found inside the oxide layer. The chlorine content increased with soaking time.

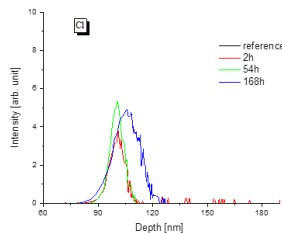


## Scanning Electron Microscopy (SEM)

During soaking, impurity metals from the electrolyte get deposited to the Al surface. Commonly found are: Pb, Cu, Ga, Ag, Zn and Ni. Cl content inside the oxide layer is highest in close proximity to these deposits.



## Secondary Neutral Particle Mass Spectrometry (SNMS)



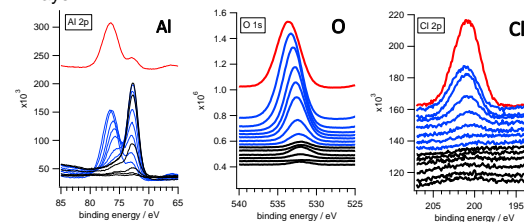
SNMS provides the possibility to probe a larger area of the sample, as well as a quantitative signal. From 2 h to 168 h soaking time, the amount of Cl in the oxide layer increases.

## Acknowledgements

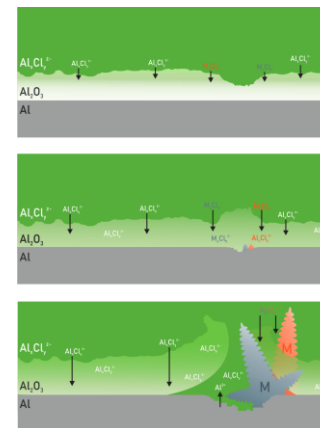
The Institute for Electron Microscopy and Nanoanalysis (FELMI) and the Center for Electron Microscopy Graz (ZFE) as well as the Institute for Chemistry and Technology of Materials (ICTM) are thanked for provision of the infrastructure. This project has received funding from the European Union's Horizon 2020 research and innovation program FET-OPEN-1-2016-2017 under grant agreement N° 766581.

## X-ray Photoelectron Spectroscopy (XPS)

XPS confirmed the Cl gradient inside the oxide layer and the soaking time dependent increase in Cl content inside the oxide layer.



## Conclusion



A model for the processes during soaking of Al in chloroaluminate DES was developed: Electrolyte impurities permeate into the oxide layer and cause the oxidation of metallic Al at the electrode oxide interface. Foreign metals are deposited and subsequently disrupt the oxide layer. Simultaneously, chloroaluminate species are permeating the oxide layer.