# Corrosion of chemical and mechanical stressed aluminium components studied with MIES, UPS, XPS and AES

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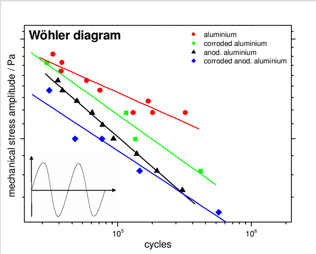
## Introduction and Motivation

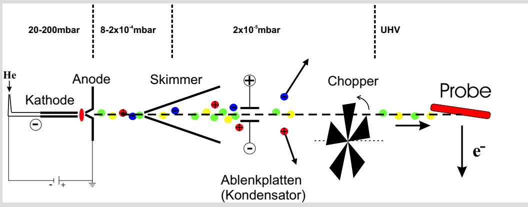
The corrosion of aluminium has been studied extensively by means of electrochemical and other methods commonly used in materials science. Although, especially the prevention of corrosion on mechanical stressed aluminium components remains an unsolved problem not only for scientific understanding but also for practical applications. To our knowledge, the influence of surface effects has not yet been investigated intensively.

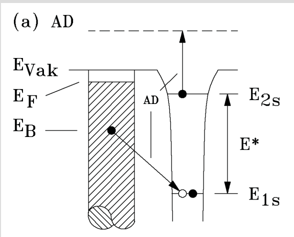
The work presented here ist part of the project "Beschichtungen für zyklisch und chemisch hoch beanspruchte Bauteile aus Aluminium" supported by the "Stiftung Industrieforschung". Aluminium components that are exposed to commercially avaible disenfectants regularly suffer from a corrosion that reduces their lifetime significantly. The commonly used form of corrosion protection is the anodisation of the material. This treatment has some undesirable side effects, as it affects the mechanical properties of the aluminium, thus reducing the lifetime of the component.




The Institut für Physik und Physikalische Technologien (IPPT) and the Institut für Maschinelle Anlagentechnik und Betriebsfestigkeit (IMAB) work together with the Institut für Werkstoffwissenschaften (IWW) to develop a proctective coating without these negative effects. Presented here are parts of the work on this problem. We try to compare measurements at aluminium surfaces produced under ultra high vacuum conditions with measurements of aluminium components from industrial application and attempt to provide a model for the reactions that make up the corrosion process and their influence on the durability of the components.

## Experimental




The Metastable Impact Electron Spectroscopy (MIES) uses metastable He*($1s^1 2s^1$) atoms as a probe for the surface density of states (SDOS).

The He* are produced in a cold cathode gas discharge which also produces ultraviolet light (HeI) line as a probe for Ultraviolet Photoelectron Spectroscopy (UPS). Both MIES and UPS spectra are taken simultaneously in using a time of flight technique.

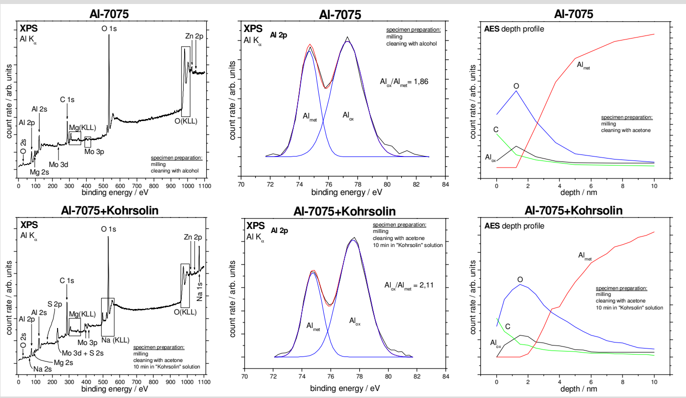
The He* interact with the specimen in front of it's surface through different mechanisms of which Auger Deexcitaion (AD) is the most important. On clean aluminium also Auger Neutralisation (AN) occurs.

Additionally, our apparatus is equipped with a X-ray source for X-ray Photoelectron Spectroscopy (XPS). All MIES/UPS and XPS spectra were collected with this apparatus in the IPPT while the shown Wöhler measurements were carried out by S. Hollunder in the IMAB.

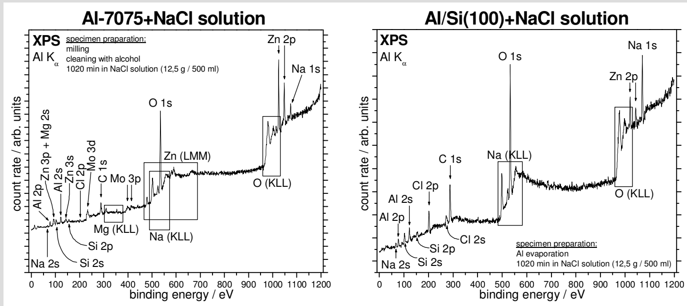
The Institut für Physik und Physikalische Technologien is further capable of collecting Auger Electron Spectroscopy (AES) spectra in combination with an electron microscope where the AES measurements of this work were carried out. Together with the use of a sputter gun depth profiles can be obtained.

Two types of samples were used during the presented work. Thin aluminium films were prepared under UHV conditions with a metal evaporator. Specimens of an aluminium alloy (EN-AW 7075 T7351) were cut from the researched aluminium components under athmospheric pressure.

## Results

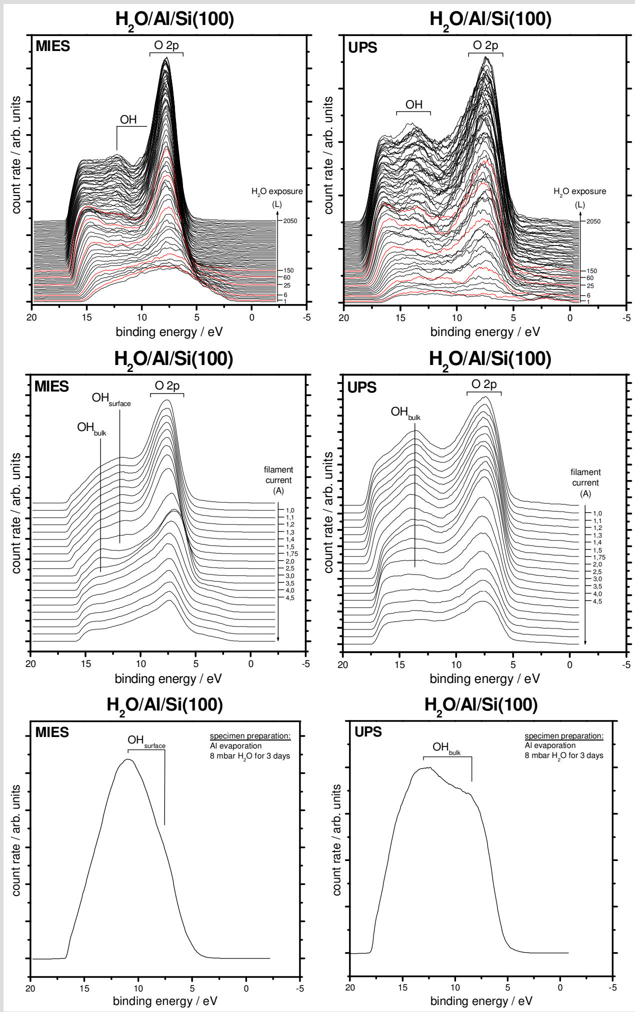



## Results and Discussion




Briefly, our experiments yield information on the progress of corrosion of the Al-7075 components during exposure to disenfectants or NaCl solution. The participating elements can be detected as well as the state of oxidation of the aluminium itself. These results are vital for the planning of the mechanical experiments in the IMAB.

Our experiments under UHV conditions try to increase the understanding of the relevant processes and produce information on the fudamental reactions of aluminium as well. The interaction of aluminium surfaces with $O_2$ is quite well investigated, while the interaction with $H_2O$ is still not fully understood. Experiments show great similarity in the interaction of aluminium with water and oxygen respectively, but also differences. The measurements indicate the dissociation of the impinging molecules and the formation of an amorpheous $Al_2O_3$ layer in both cases as reported in literature. The interaction with water additionally yields to the formation of aluminium hydroxide in the surface. The reaction is amplified by the presence of NaCl at the surface.




Work is still in progress on this matter. Next steps will include the characterisation of new protective coatings for the aluminium components which are produced by the IWW using nanoparticles.

## Literature

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