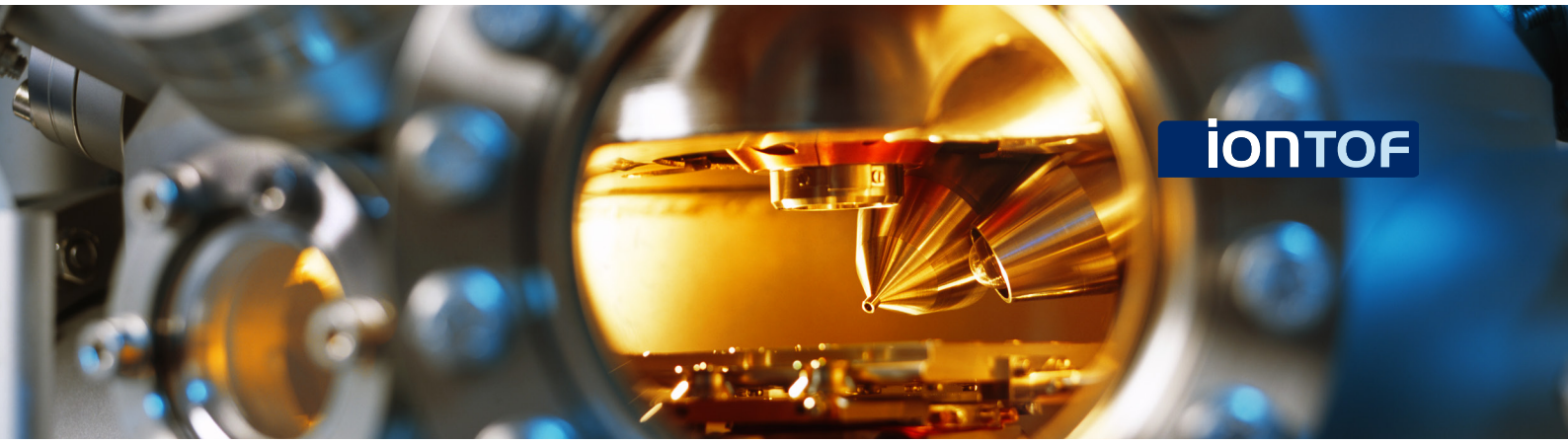


6 9

LEIS analysis of the chemical leaching effects in a Pt-Cu alloy nanoparticle catalyst

Proton-exchange membrane (PEM) fuel cells are a potential key component in future energy conversion technology. In these cells, carbon supported Pt-Cu alloy nanoparticles are used as a catalyst for the oxygen reduction reaction.

The use of alloy particles, which expose a Pt skin in the active state, is essential to reduce Pt demand and therefore cost. In this study, the intentional formation of this Pt skin by electrochemical leaching of the particles is studied with the Qtac.

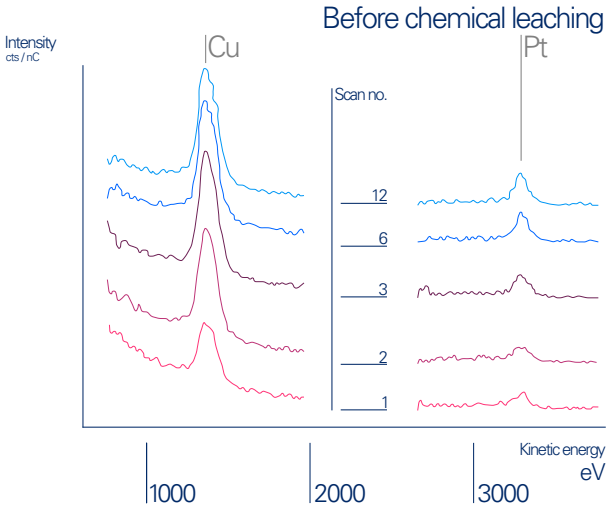
The LEIS measurements of the 3 - 5 nm particles before and after leaching illustration that the as-prepared particles show a strong enrichment of Cu while the leached particles have an almost pure Pt layer at the surface.

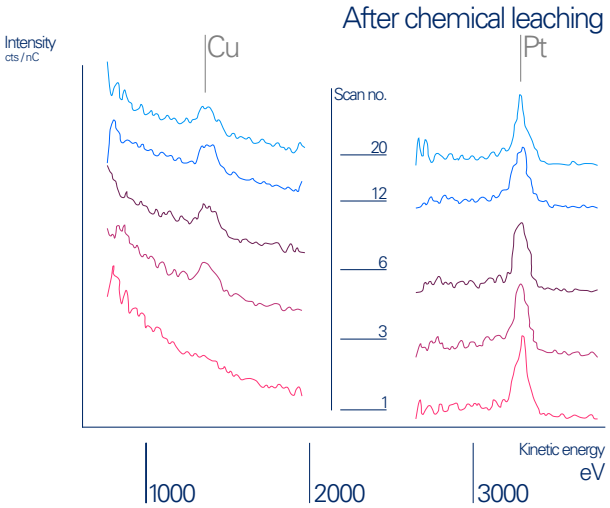
Heisenbergstraße 15
48149 Münster
Germany

Phone +49 251 1622-100
Email sales@iontof.com
Internet www.iontof.com

Surface composition of 3 - 5 nm particles

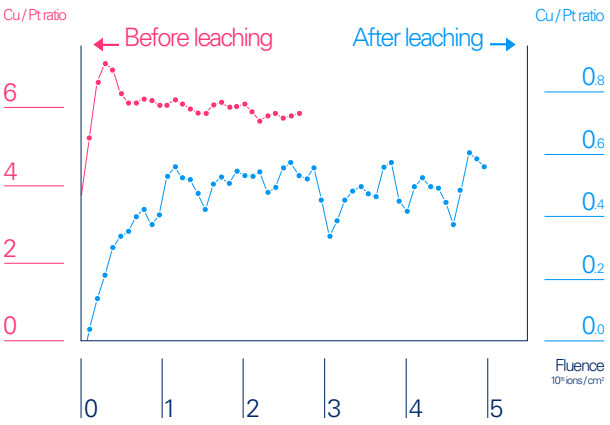
When acquiring multiple spectra on the same location, some sputtering by the primary beam occurs; by choosing appropriate conditions, the series of spectra represents a depth profile over the first approx. 3 atomic layers. After a thin contamination layer has been removed with a fluence of 0.25×10^{15} ions/cm^2, the Cu enrichment in the outer layer is visible for the samples without leaching. The leached particles on the other hand show a significant depletion in Cu until a fluence of approx. 1×10^{15} ions/cm^2 (corresponding to sputtering of about 1 atomic layer) is reached. After that, the Pt/Cu ratio becomes constant in both cases.





5 keV Ne^+ scattering spectra of the particles before and after electrochemical leaching. Scan No. 1 corresponds to the surface; increased number of scans correspond to larger ion fluence applied, imitating a depth profile over a few atomic layers.

The LEIS results in this study validated the assumption of the formation of a Pt layer upon electrochemical leaching of Pt-Cu alloy nanoparticles on a carbon support. They further showed that only a single Pt layer is formed and the depth profiles agree with XRD measurement showing the compositional changes caused by the leaching, even in the particle core.



Cu/Pt ratio as a function of primary ion fluence before and after leaching. Before leaching Cu is dominating the first few atomic layers, while after leaching Pt is strongly enriched.

This study was performed in collaboration with Tascon GmbH and the group of Prof. Grünert, Ruhr-Universität Bochum. For further details see O. Petrova et al., ChemElectroChem 2016, 3, 1768-1780, DOI: 10.1002/celc.201600468