In-Situ Investigation of Discharging of Alkaline Batteries by Means of Tomography

Ingo MANKE, John BANHART, Simon ZABLER, TU Berlin, Germany and Hahn-Meitner-Institut, Berlin, Germany;
Astrid HAIBEL, Nikolay KARDJILOV, Hahn-Meitner-Institut, Berlin, Germany;
Alexander RACK, Forschungszentrum Karlsruhe, Eggenstein-Leopoldshafen, Germany;
André HILGER, Technische Fachhochschule Berlin, Germany

Abstract. Alkaline batteries are widely used for electronic devices and are still a subject of research and development. A key for further improvements (e.g. development of rechargeable alkaline batteries) is the understanding of the electrochemistry and the knowledge of the spatial distribution of the different chemical ingredients under conditions that are close to that found in real devices. For that purpose mainly techniques for surface analysis are used e.g. optical microscopy and SEM (scanning electron microscopy). However the preparation of the batteries is not easy because they have to be cut and oxidation and corrosion of the zinc particles and flowing of the electrolyte affect the surface. Moreover there is a big waste of material and after preparation the battery is destroyed and can not used for further investigations.
In this paper we present investigations on commercial alkaline AAAA, AAA and C battery cells using synchrotron and neutron tomography as tools for non-destructive in-situ analysis of chemical processes. The batteries have been stepwise discharged and were measured after each step. The development of the spatial distribution of Zn and MnO2 and their reaction products was visualized three-dimensionally. It was shown, that even the dissolving of single zinc particles inside the cell can be analyzed in detail. Furthermore the changes in the size distribution of the zinc powder have been calculated using special software tools (e.g. watershed transformation).
At the cathode side micro-cracks appear due to swelling of the MnO2. This is correlated with a strong increase of hydrogen content at the edge of the cathode that was found in the neutron tomography investigations. At the same time the hydrogen content decreased at the location where the zinc oxidised.