In-Situ Characterization of Active Materials in Ni-MH and Li-ion Batteries by Electrochemical Acoustic Emission Method

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In various battery technologies, the volume variation of the active materials with cycling induces their cracking, which affects the battery cycle life by accentuating their corrosion by the electrolyte and/or by inducing a loss of electronic connectivity within the composite electrode. This is the case of metal hydride ($LaNi_5$, MgNi...) anodes for Ni-MH batteries or Li_xM (M = Si, Sn...) anodes for Li-ion batteries. To date, the study of the electrode cracking is generally limited to a post mortem examination of the electrode by microscopy. This does not allow a detailed analysis of the electrode cracking process, which can significantly vary depending on the electrode composition, the electrode processing and the cycling conditions.

We have recently shown that acoustic emission (AE) technique can be successfully applied for the *in situ* monitoring of the cracking of MgNi and $LaNi_5$-based electrodes for Ni-MH batteries [1-4]. On the basis of the AE measurements, it was demonstrated that the pulverization mechanism of MgNi strongly differs from that of $LaNi_5$ [1-3]. In addition, the influence of the particle size and charge rate on the cracking of the MgNi electrode was highlighted [3]. The positive influence of the Ti substitution and Al addition on the MgNi-based alloy pulverization resistance was also demonstrated [4].

In the present work, acoustic emission coupled with electrochemical measurements is performed on different metal-hydride anodes for Ni-MH batteries and on Si-based anodes for Li-ion batteries. For Ni-MH batteries, the influence of the composition of $LaNi_5$-based and MgNi-based alloys (Fig. 1) on their cracking resistance will be shown. For Li-ion batteries, the influence of the Si nanostructuration by ball-milling, the electrolyte composition and the electrode state-of-charge or discharge (Fig. 2) on the AE activity and electrode cycle life will be presented.

References
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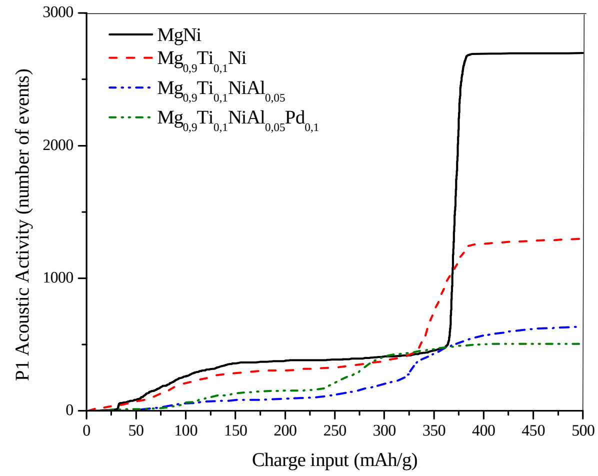

Figure 1. Evolution of the acoustic activity (number of events) resulting from the cracking of MgNi, $Mg_{0.9}Ti_{0.1}Ni$, $Mg_{0.9}Ti_{0.1}NiAl_{0.05}$ and $Mg_{0.9}Ti_{0.1}NiAl_{0.05}Pd_{0.1}$ electrodes as a function of the charge input during the first charge.

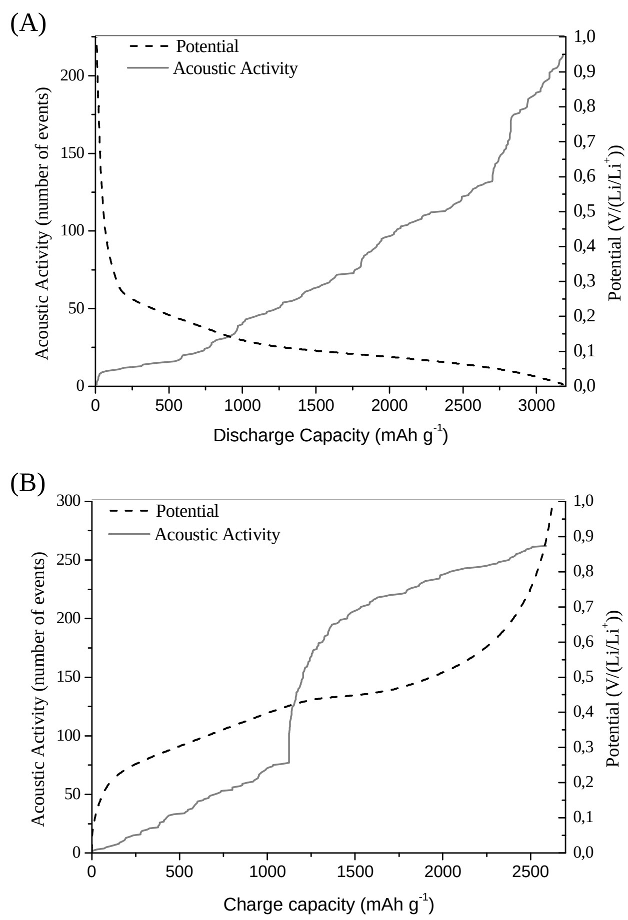

Figure 2. Evolution of the acoustic activity (number of events) during the first discharge (A) and charge (B) of a Si-based anode.