Characterisation of the effect of pulsed recharge current on lead acid batteries using radioelement detection

F. Mattera*, D. Benchetrite*, O. Bach*, M. Le Gall*, G. Gousseau**
*: CEA-GENEC B[t] 351 CEA-Cadarache, 13108 St-Paul-lez-Durance, FRANCE
Tel: + 33 4 42 25 21 13
Fax: + 33 4 42 25 73 65
Email: florence.mattera@cea.fr
**: CEA-SAT B[t] C2 CEA-Grenoble, Avenue des Martyrs, 38000 Grenoble, FRANCE

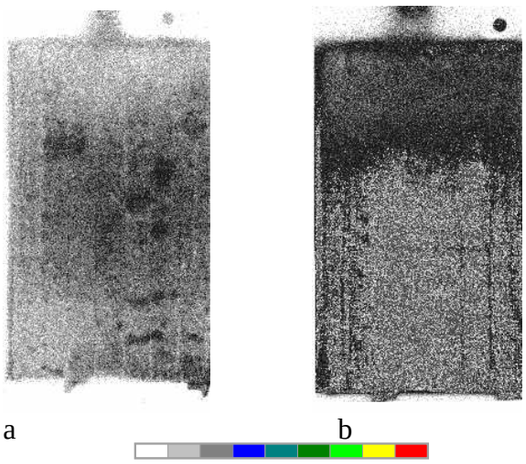
Objectives: The most commonly used mean for storing photovoltaic energy is lead acid battery technology, due to its low cost and great availability. However, for this application, where it is not possible to control the battery recharge (which depends on the amount of sunlight) a problem of electrodes sulphation can arise. The ageing phenomena affect mainly the positive electrodes. Several previous studies have underlined the beneficial effect of pulsed recharge currents leading in some cases to an increase of the discharged capacity (up to 20%).
But different questions had to be solved:
1. What is the real impact of the pulsed recharge on the sulphation phenomena?
2. What is the consequence on the battery ageing?

Method: In order to answer these questions a non-destructive technique has been used to characterise the distribution of radioactive lead sulphate ($Pb^{35}SO_4$) by laser reading of photostimulable screens. The tracers are integrated into the battery and can be detected by the β radiation they emit. For our study, a radioactive sulphuric acid ($H_2{}^{35}SO_4$) was used in two different experimental cells subjected to cycling:

- Intensiostatic charge / discharge cycles (C/10 rating) for the reference cell,
- Pulsed recharge current and intensiostatic discharge for the tested cell.

The electrode «maps» were then used to characterise the sulphation after 20, 40, 60 and 80 cycles.

Results: The electrodes maps and the qualitative analyses related have clearly shown that the pulsed recharge lead to better recharge of the positive active mass with lower levels of sulphation for the tested cells (Figure 1a) than for the reference cell (Figure 1b) up to the 80th cycle, as well as higher discharged capacities. In this paper, these results will be presented and the electrochemical phenomena explained using lead-acid battery recharge model developed in the laboratory.



($Pb^{35}SO_4$) Intensity scale

Fig1 : Positive $PbO_2/PbSO_4$ electrodes maps after 40 cycles
a. Tested cell with optimised recharge,
b. Reference cell.