Performance of Gaensel Energy Group's Nikel Storage Cells: Case Study

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Abstract

Last January Gaensel Energy group acquired 30% of Protonstar, this acquisition allowed the further development of Nikel storage cells. The extraordinary property of this new generation of accumulators lies in the accumulation of energy and its releasing no longer depending upon electrochemical processes, but simply on the interaction at the metal lattice level, in this case the Nickel. To date, we are facing a third generation of accumulators, in fact from the Volta's battery, called primary, the electrochemical cells called secondary, in use today, having the prerogative to be rechargeable. Any storage system currently used is based on three basic components showing electrochemical linkage, namely an anode, a cathode and an electrolyte.

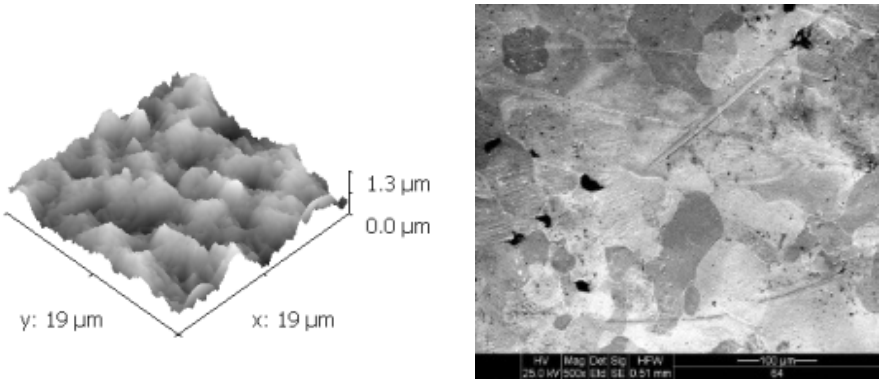
Keywords: *cell performance, Nickel storage cells, energy accumulation, charge, protonstar*

1. Introduction

1.1 Description of the case study

The anodes, generally based on graphite, over the years went through changes in their chemical composition up to the manufacturing of nano-structured materials based on carbon, tin and silicon. Cathodes are the components which underwent the greatest changes over the years, the aim was to be able to create "porous" materials capable of hosting lithium ions. These are complex materials consisting of various elements such as aluminum, oxygen, lithium iron phosphate, and cobalt, the latter of which holding a well-known toxicity.

Electrolytes, generally formed by a solution of lithium salt in a mixture of organic solvents such as ethylene carbonate and dimethyl carbonate, must guarantee a fair mobility of the lithium ions, i.e., a high ionic conductivity, during the intercalation and de-intercalation phases of the lithium ions. Only recently Research made available electrolytes in a gel or ceramic solid-state form.



Charge and discharge cycles, environmental conditions of use, and the basic materials of which the secondary electrochemical cells are made of, determine their characteristics; such characteristics determine also their life cycle, or a period of time beyond which the accumulator is no longer usable due to its "natural death" or because its performance is so compromised to be no longer economically advantageous. Furthermore, the characteristics of the electrolyte and the intercalation and de-intercalation capacity of anodes and cathodes affect the performance coefficients of the batteries themselves, so much so that in general the higher the energy delivered the more the efficiency decreases. All these types of electrolytic cells suffer enormously from periods of maximum discharge, and from recharging methods, some still show a memory effect, which further decreases their performance. When we refer to energy storage systems, inevitably, large powers are associated with large volumes and large weights, so much so as to make it unthinkable to be able to create "prêt a porter" instrumentation of great powers.

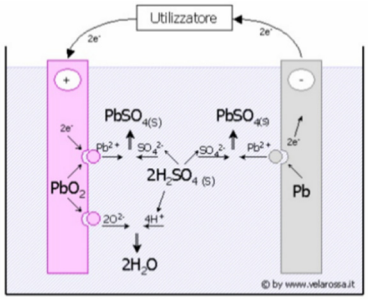


Figura 1.9: *Rappresentazione della reazione* $Pb+PbO_2+2H_2SO_4 \rightarrow 2PbSO_4+2H_2O$. *Processo di scarica di una cella di una batteria piombo - acido* [14].

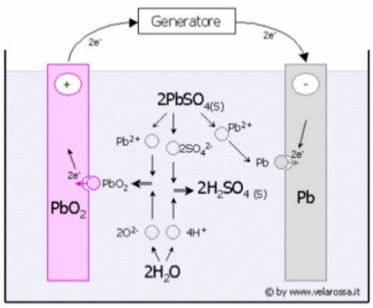
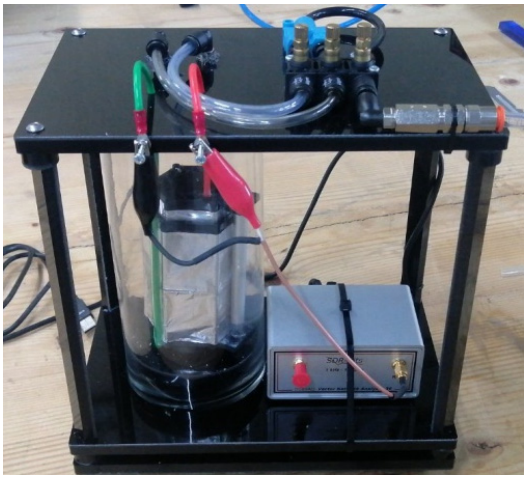


Figura 1.10: *Rappresentazione della reazione* $2PbSO_4+2H_2O \rightarrow Pb+PbO_2+2H_2SO_4$. *Processo di carica di una cella di una batteria piombo - acido* [14].

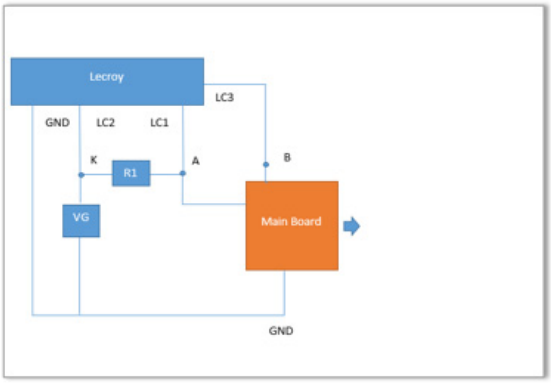
The cells, based on the innovation introduced by **Protonstar**, approach a model that is not dependent on the electrochemical interactions of the materials used. The approach is in fact based on metal lattice interactions, thus making it possible to use metals such as Nikel, abundant, inexpensive, recyclable with low-cost and low environmental impact processes. This approach has enormous advantages, first of all, an exponential increase in the charge density of the cell, that is, cells of great power with a low weight and small footprint. The second but equally important goal is the use of materials that from the point of view of environmental impact are absolutely irrelevant, both during the production process, as well as in disposal and possibly recycling.



2. Performance Analysis

The cell performance study was conducted at the Physics laboratory of the UAMD University of Durres in Albania. Below are the results of the tests carried out at the UAMD University Physics Laboratory.

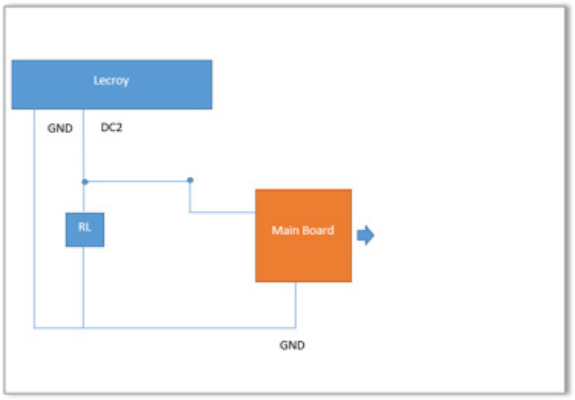
In this experiment the data are taken with a Lecoy Wave Surfer 44Xs oscilloscope with 500Hz oversampling.
Loading setup:



Equipment:
Oscilloscope: LECROYWS44Xs
Serial: 17268
Sampling rate 500 samples per seconds
Samples: 810423 Loading
Low pass filter: ON
3 more bits virtual enhancements

Loading Setup:
R1=10,1 ohm
I set Point= 10mA

Loading Curve:
LC1 is The Voltage across the DUT
The LC1 and LC2 are the voltage across R1
According to Test Plan the current is I=(LC2-LC1)/R1

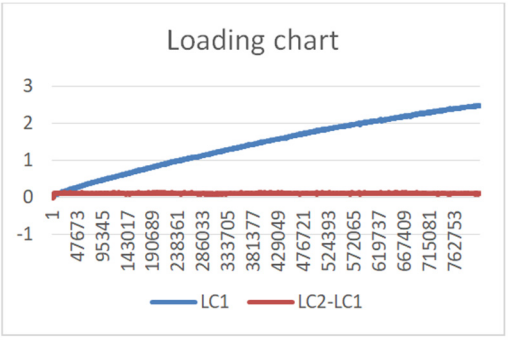


Equipment:
Oscilloscope: LECROYWS44Xs
Serial: 17268
Sampling rate 500 samples per seconds
Samples: 648759 Deloading
Samples: 810423 Loading
Low pass filter: ON
3 more bits virtual enhancements
Deloading Setup:
RL=10,09 ohm
Deloading Curve:
DC2 is The Voltage across the RL

Deloading setup:

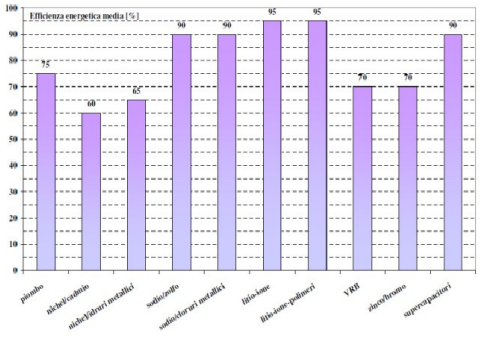
Below are the Loading and Deloading charts, obtained on the basis of the raw data acquired during the experiment.

The experiment aims to verify the efficiency of the cell, measuring the injected energy and that which is recovered. The relationship between the two energies, expressed in **Joule**, gives precisely the efficiency coefficient.

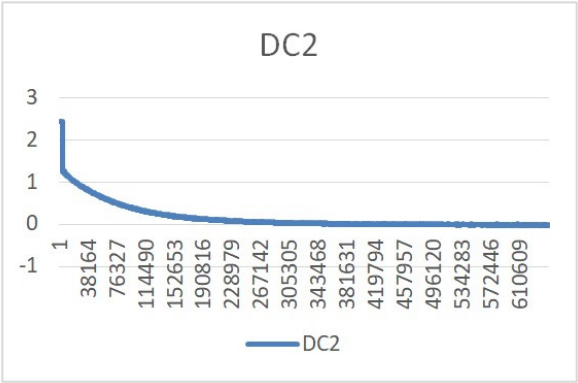


Energy spent on loading 26.29147 Joule

$$coefficient\ of\ performance = \frac{17{,}3222}{26{,}29147} = 0.66$$



Performance coefficients of some types of batteries



Energy recovered in the deloading phase 17,3222 Joule

3. Conclusions

Although the results seem barely comparable to metal hydride batteries, it should be noted that in the deloading phase, a satisfactory quantity of hydrogen is released, which can be used as it is, or used in a fuel cell. Adding the energy released in the form of hydrogen, the results are more than comparable to lithium ion systems. One of the next experiments, the objective is to measure the quantity of hydrogen released, this value will allow to have a more precise estimate of the efficiency of the interaction cell at the metal lattice level.

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