Position paper of the European Battery Industry

on the fundamental role of the design and shape

of a battery

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PART 1. The fundamental role of the internal design of a battery.

A battery is a device which delivers electrical current to an external appliance by converting the chemical energy contained in its active materials directly into electric energy by means of an electrochemical oxidation-reduction (REDOX) reaction.

Alessandro Volta's invention of a battery is described as follow in a letter dated March 20th 1800 ([1])…

> "*The apparatus to which I allude and which will no doubt astonish you is only the assemblage of a number of good conductors of different kinds arranged in a certain manner…*".

In order to illustrate the importance of the internal design of a battery over its chemical composition, it is worth referring to the Handbook of Batteries by D. Linden and T.B. Reddy[2]. In Chapter 1 "Basic Concepts", one can read the following statements under the § 1.1 "Components of cells and batteries".

> *"The electrodes inside a battery are electronically isolated in the cell to prevent internal short circuiting. In practical cells designs, a separator is used to separate the anode and the cathode electrodes mechanically. The separator however is permeable to the electrolyte in order to maintain the desired electronic ionic conductivity between the electrodes. Electrically conducting grid structures are also added to the electrodes to reduce internal resistance.*
>
> *The cell itself can be built in many shapes and configurations – cylindrical, button, flat and prismatic – and the cells components are designed to accommodate the particular cell shape.*

The Chapter 5 of the same document refers to "Battery Design", it starts with the following sentence.

> *Proper design of the battery or the battery components is important to assure optimum, reliable and safe operation. Many problems attributed to the battery may have been prevented had proper precautions been taken with both the design of the battery itself and how it is designed into the battery operated equipment.*

Those basic statements on the necessity to design the components in order for the battery to become and remain operational are fully independent of the chemicals used in the battery; those are general statements about the fundamental importance of the proper design of a battery.

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[1] "On the electricity excited by the mere contact of conducting substances of different kinds". Letter from Mr. Alexander Volta, Professor at the University of Pavia to Sir Joseph Banks, Chairman of the Royal Society. March 20th 1800. Page 2. Reprint by Ed. U. Hoepli. Milano 1999. ISBN 88-203-2762-7

[2] Handbook of Batteries (Third Edition) 2001 by David Linden & Thomas B. Reddy. McGraw-Hill Handbooks. ISBN 0-07-135978-8

Independently of any chemical system, the internal design of the battery with its mechanical assembly of current collectors, electrodes and separator has been used in many shapes in order to build cylindrical, prismatic or thin film batteries. An historical development of the external shape and internal design of batteries is illustrated in Annex 1 below while a short discussion on the role of chemicals in the functioning of a battery is supplied in Annex II.

More specifically, it is observed by comparing Figures 4 and 5 in Annex 1 that, for a given technology (the lead-acid battery system) and for an identical external prismatic shape, two different types of assembly of internal components (current collectors, electrodes and separator) of the battery can be used. Those changes of the internal design will differentiate the overall performances and specifications of those batteries.

Conclusion.

It is the evaluation of the European Battery Industry that, in accordance with the definition of "***articles***" in the Article 3 § 3 of REACH, the battery is considered as an article because it is an object which during production is given a special shape, surface or design which determines its function to a greater degree than does its chemical composition.

PART 2. Car batteries.

Since the end of 1980's, maintenance free batteries have been developed and used successfully on the car market and are now the standard product on the market.

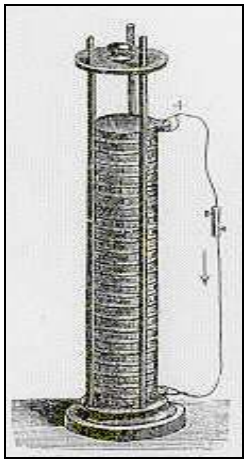
This has been obtained by an appropriate design of such batteries as illustrated in Figure 4 and 5 of Annex I: car batteries need no maintenance from the car owner.

Therefore, under normal or reasonably foreseeable conditions of use, there is no intention of release of the chemical content of a car battery.

In any case, batteries are "articles" under the definition of Article 3. §3 of REACH.

Annex 1. Illustrations of the evolution of the design and shapes of batteries.

1. **The Volta battery (1800) (Silver - Zinc)**



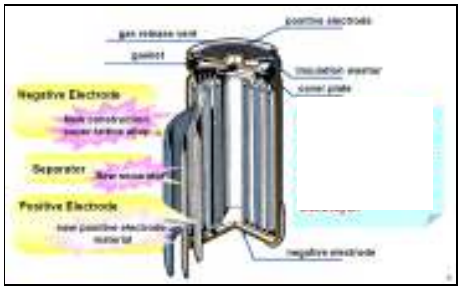
2. **The Gaston Planté Battery (1859) (Lead-acid)**

3. **The Lechanché battery (1920) (Lead-acid)**

4. A modern SLI Battery (1995)
(Lead-acid maintenance free).

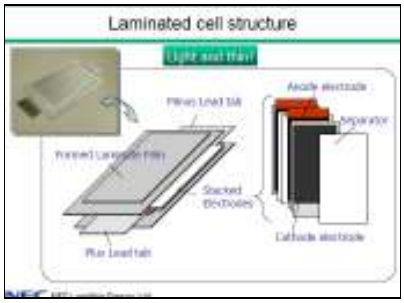
5. A high Performance sealed battery (2000)-(Lead-acid maintenance free)

6. A sealed cylindrical battery (1990)
(Nickel-Metal hydride)



Similar assembly is used for
Nickel-Cadmium and Nickel-Zinc batteries.

7. A sealed Thin Film Battery (1995)
(Lithium-Ion battery)

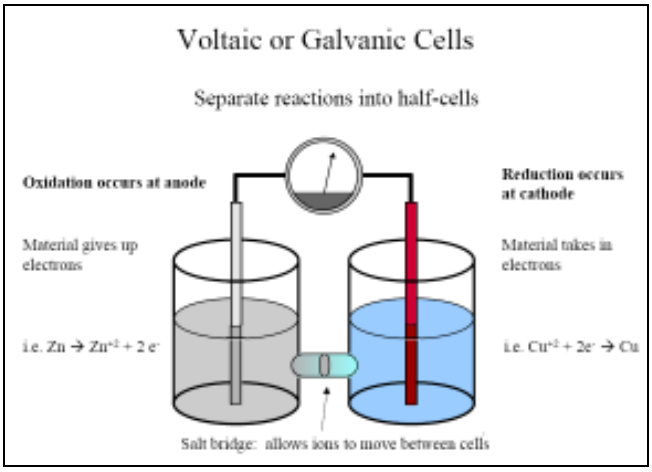


Similar design is used for Zinc-alkaline
Polaroid-type and Lithium-ion cells.

Annex 2. The control of the REDOX process occurring in a battery.

Many REDOX couples may be used to prepare a battery; a non-exhaustive list of those REDOX couples is supplied in the referenced Handbook of Batteries Table 1.2. [3]. The use of chemicals is necessary but it is not sufficient to build a battery. Indeed mixing chemicals in a container does not produce a battery.

The proper design of the assembly of two separate current collectors, of two active electrode materials (REDOX couple), of the electrolyte (solvent and salt) and of the ionic separator leads to the preparation of a battery. This is illustrated in the Figure below.



The difference between a REDOX process occurring in a chemical reactor and a battery is that in the first case, the exchange of electrons occurs in the bulk of the reactor between chemicals while in the second case the exchange of electrons is channeled at the electrodes surface and the flow of electrons is used as an external source of electrical energy. For the REDOX process to continue in a battery, the external flow of electrons outside the battery must be balanced by an internal flow of ions (ionic charges) inside the battery.

Failure to realize this balance by the appropriate design of the battery and the engineered assembly of its components will stop the functioning of the battery as a result of the build up of uncompensated electrical charges like in a capacitor.

[3] Handbook of Batteries (Third Edition) 2001 by David Linden & Thomas B. Reddy. McGraw-Hill Handbooks. ISBN 0-07-135978-8