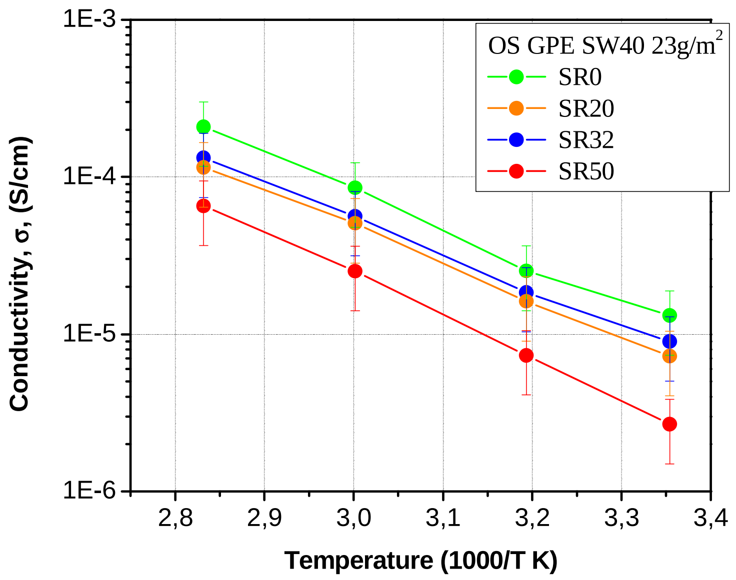
APPENDIX A

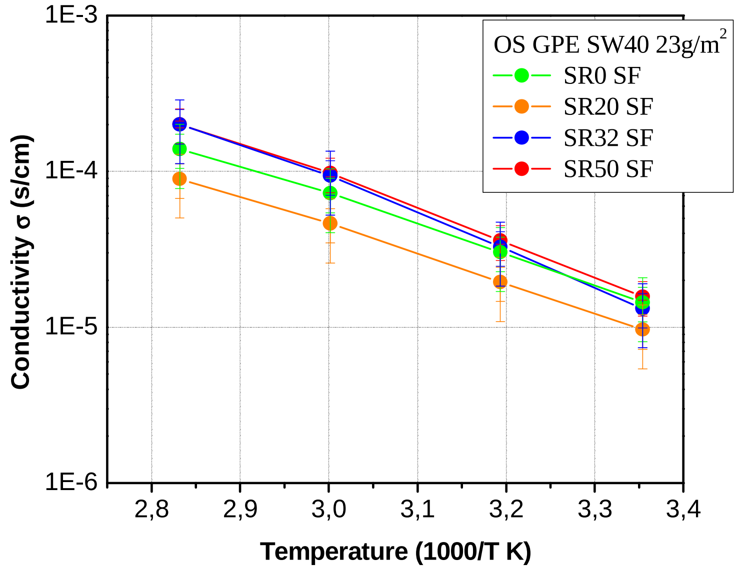
COMPLETE RESULTS ON THE REFINING SERIES (Chapter III)

Conductivity

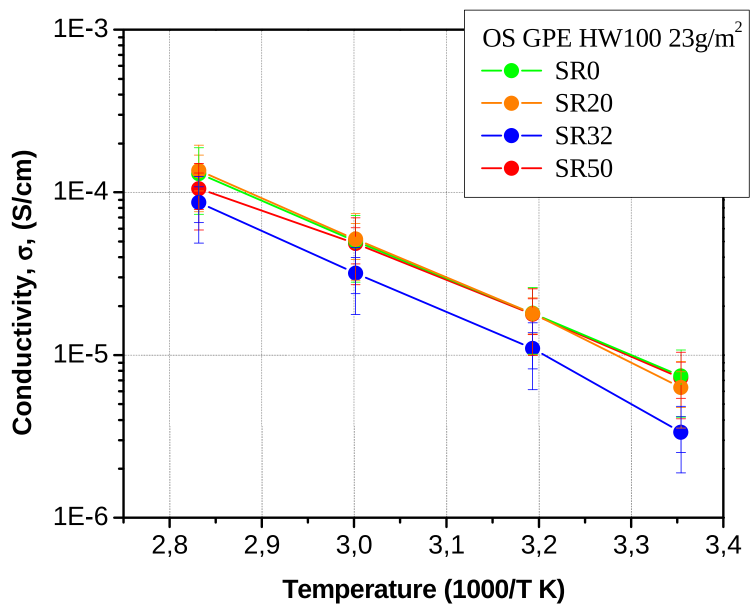
- Arrhenius plots of the conductivity of One shot GPEs reinforced with handsheets with grammage 23gm^{-2} containing the mixture of fibres HW:SW (60:40), with different refining degrees.



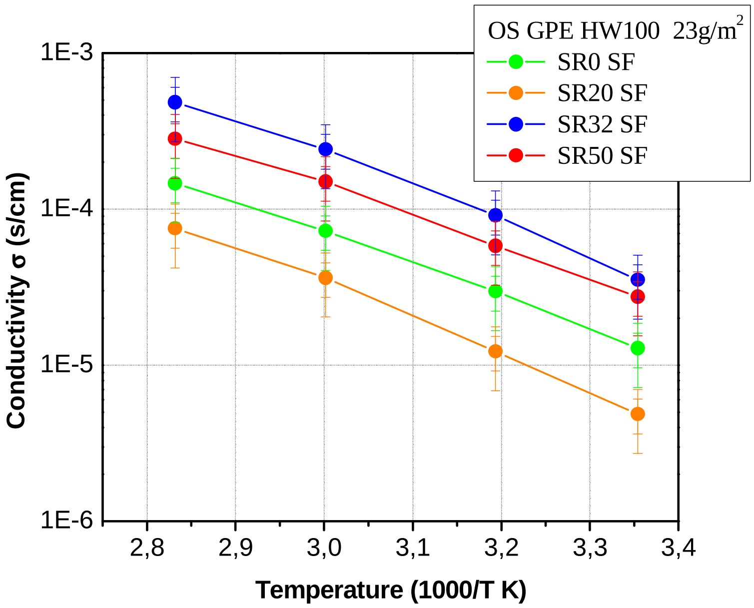
- Arrhenius plots of the conductivity of One shot GPEs reinforced with handsheets with grammage 23gm^{-2} containing the mixture of fibres HW:SW (60:40), with different refining degrees without short elements.



- Arrhenius plots of the conductivity of One shot GPEs reinforced with handsheets with grammage 23gm^{-2} containing fibres HW (HW100), with different refining degrees.



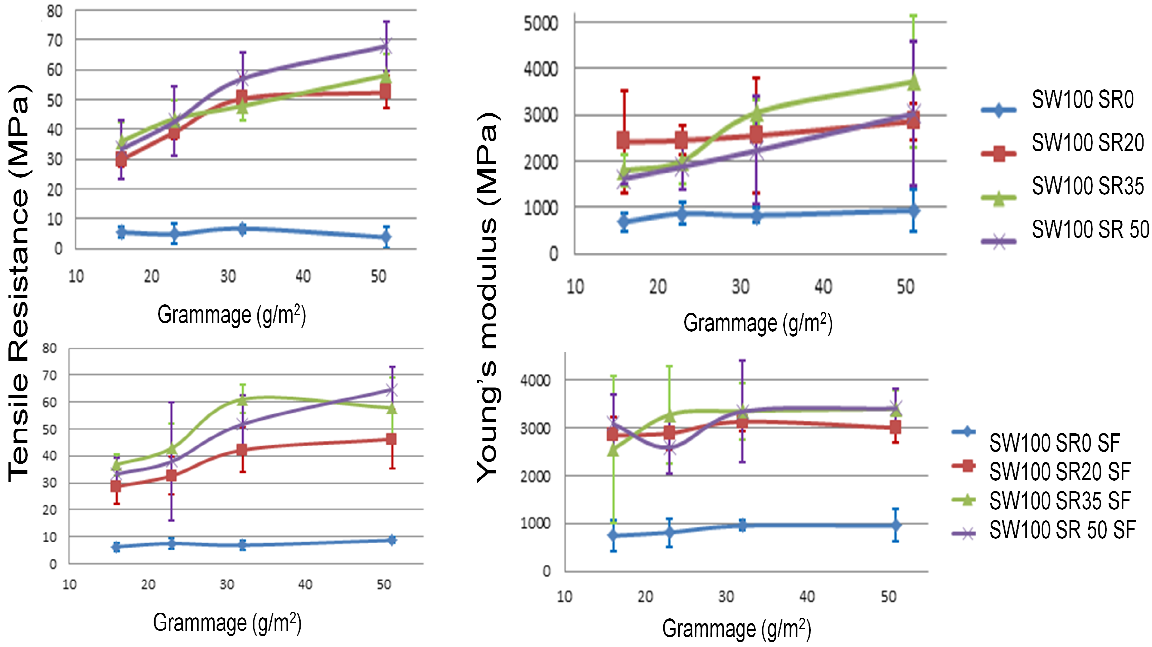
- Arrhenius plots of the conductivity of One shot GPEs reinforced with handsheets with grammage 23gm^{-2} containing fibres HW (HW100), with different refining degrees without short elements.



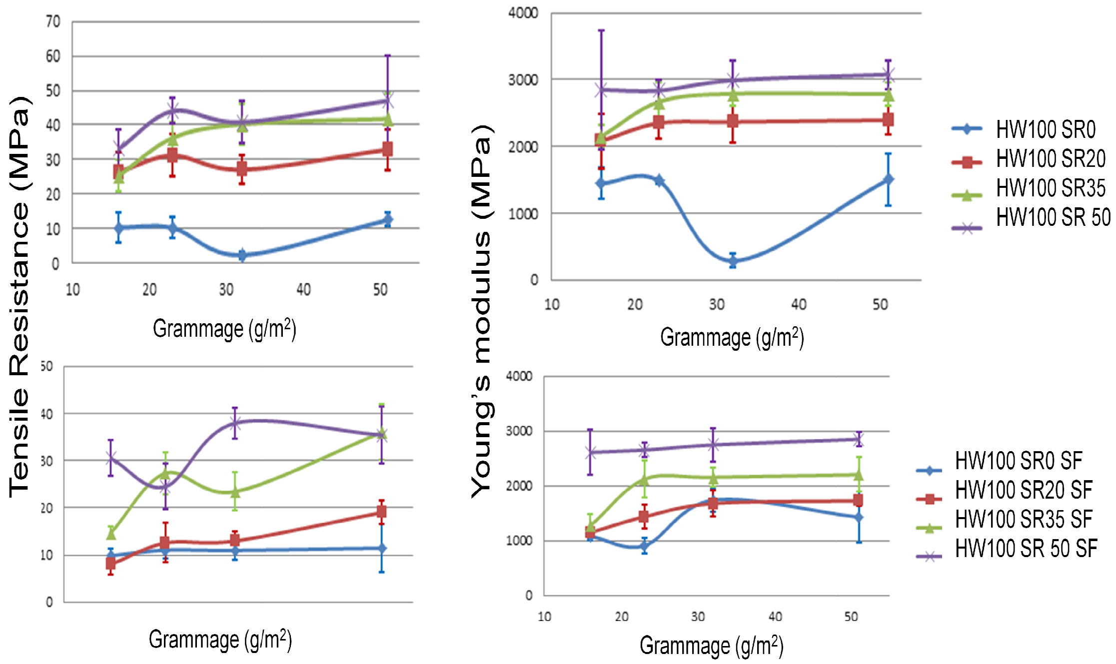
Mechanical properties

Handseets

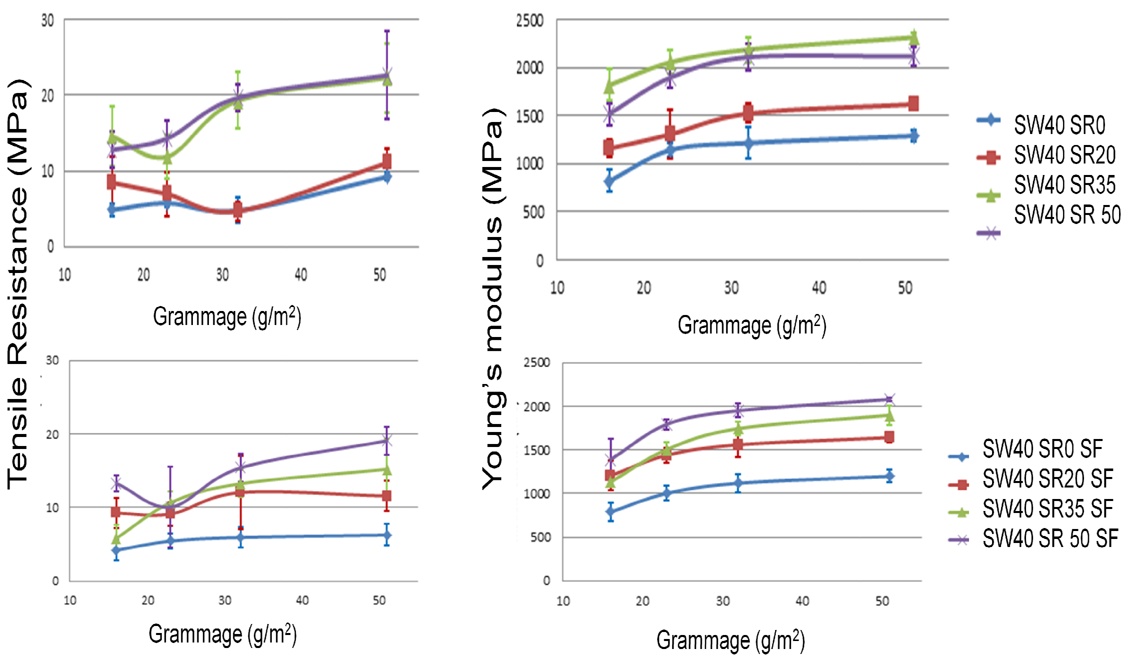
- Tensile resistance (left) and Young's modulus (right) of the hansheet refining series prepared with SW fibers (SW100) with (top) and without (bottom) short elements as a function of the grammage



- Tensile resistance (left) and Young's modulus (right) of the hansheet refining series prepared with HW fibers (HW100) with (top) and without (bottom) short elements as a function of the grammage

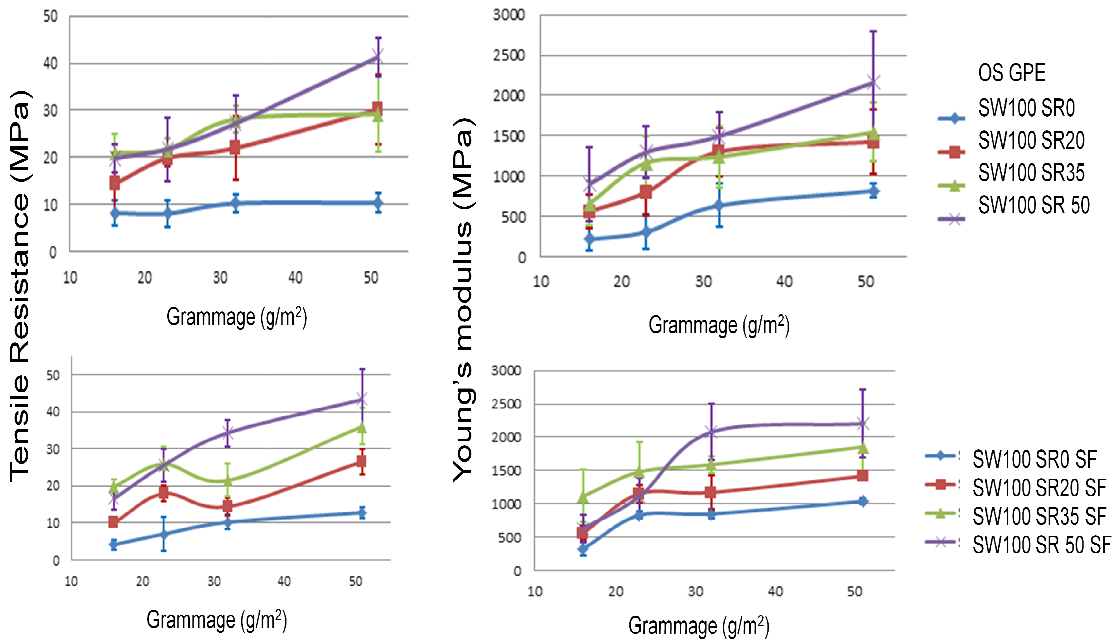


- Tensile resistance (left) and Young's modulus (right) of the hansheet refining series prepared with the mixture of fibers HW:SW (60:40) (SW40) with (top) and without (bottom) short elements as a function of the grammage

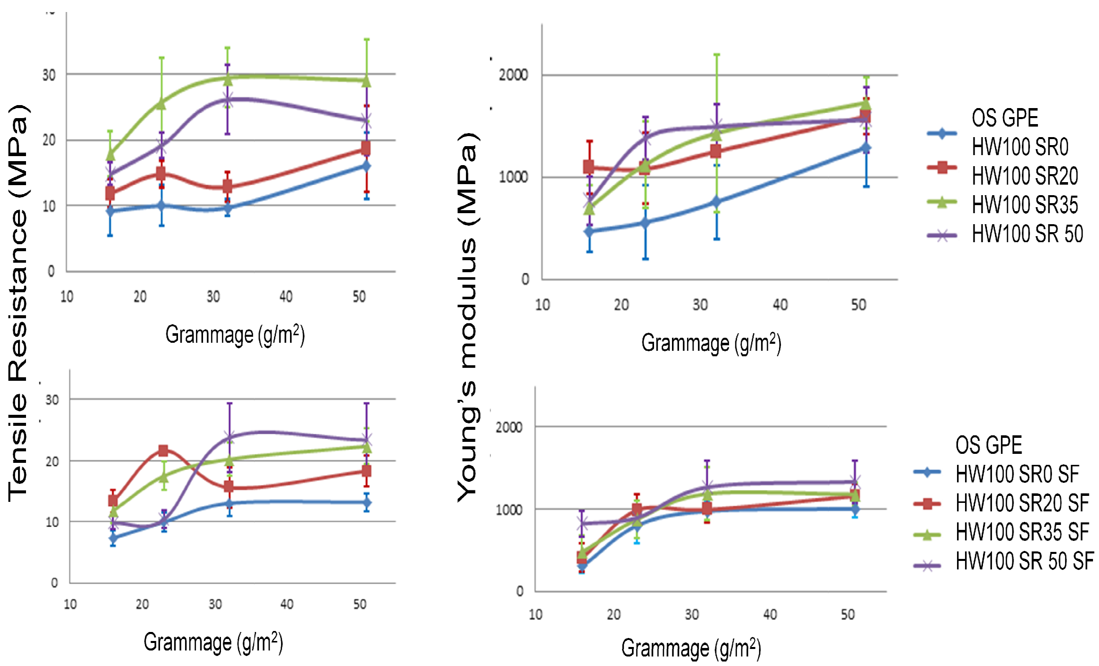


One Shot GPE membranes

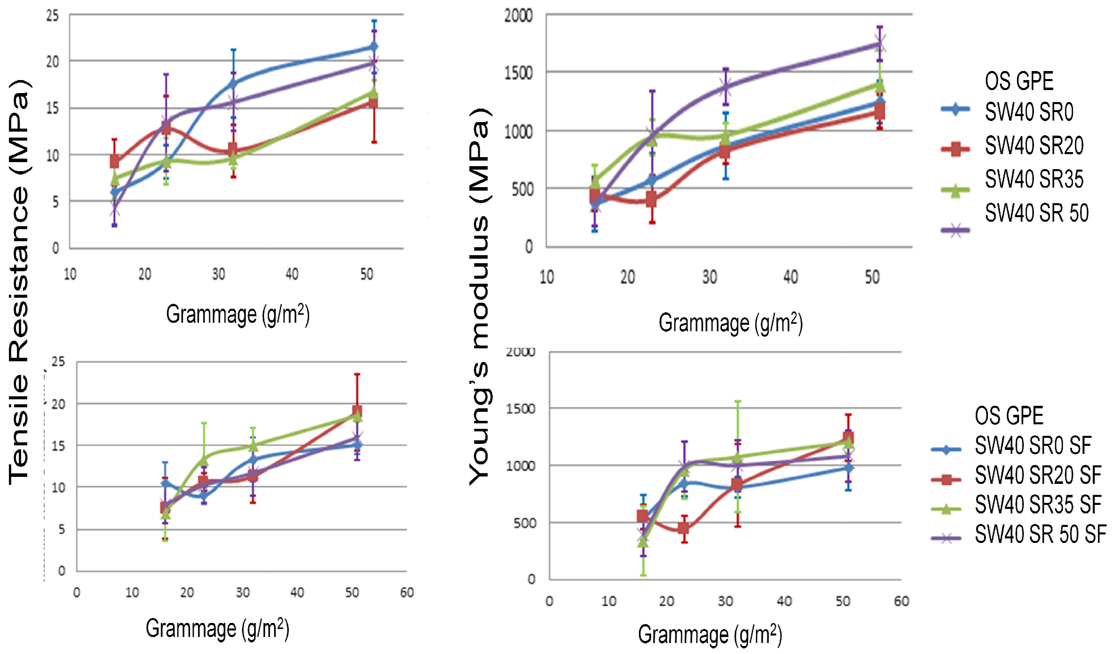
- Tensile resistance (left) and Young's modulus (right) of the One Shot GPE membranes reinforced with the handsheets of the refining series prepared with SW fibers (SW100) with (top) and without (bottom) short elements as a function of the grammage



- Tensile resistance (left) and Young's modulus (right) of the One Shot GPE membranes reinforced with the handsheets of the refining series prepared with HW fibers (HW100) with (top) and without (bottom) short elements as a function of the grammage



- Tensile resistance (left) and Young's modulus (right) of the One Shot GPE membranes reinforced with the handsheets of the refining series prepared with the mixture of fibers HW:SW (60:40) (SW40) with (top) and without (bottom) short elements as a function of the grammage



APPENDIX B

ELECTROCHEMICAL CELLS GLOSSARY

The performance of a battery is expressed by many quantities. The most important ones, in designing a battery, are capacity, energy density, power density, rate capability and cycle life.

CAPACITY (Q) is defined as the total amount of electric charge supplied by the system or by the electrode materials and it is usually expressed in terms of Coulomb (C) or Ampere hour (Ah); 1 Ah = 3600 Coulombs. It can be calculated as the product of the current by the time:

$$Q = i \times t \quad (I.1)$$

SPECIFIC CAPACITY means the capacity per unit mass (Ah g–1) or per unit volume (Ah dm^{-3}). FULL CHARGE CAPACITY is the remaining capacity of a fully charged battery at the beginning of a discharge cycle, and FULL DESIGN CAPACITY is the remaining capacity of a newly manufactured battery.

THEORETICAL CAPACITY (Qt) is the maximum amount of charge that can be extracted from a battery with respect of the amount of active material it contains and it can be calculated as follows:

$$Qt = x \times n \times F \quad (I.2)$$

where x is the amount of active material in moles, n are the equivalents exchanged and F is the Faraday constant.

CHARGE EFFICIENCY (Y) is the percent ratio of capacity supplied in discharge (Qd) and capacity accumulated during the previous charge (Qc):

$$Y= (Qd / Qc)*100 \quad (I.3)$$

C-RATE measures the applied current to charge or discharge a battery; it is expressed in fractions or multiples of C. A C-rate of 1C corresponds to the current required to fully discharge a battery in 1 hour, 0.5C or C/2 refers to the current to discharge in two hours and 2C to discharge in half an hour.
The ENERGY (E) of an electrochemical power source can supply expressed in Joule (J) or more commonly in Watt hour (Wh), is related to the capacity through the equation:

$$E = Q \times V \quad (I.4)$$

where V is the average operating voltage delivered by the system.
SPECIFIC ENERGY (or usually ENERGY DENSITY) is defined as the energy output from a battery per unit mass (Wh/g) or per unit volume (Wh/dm^3).
The POWER (P) delivered by a material or a power source is defined as the average working voltage multiplied by the flowing current.
ANODE is the negative electrode of a primary cell associated with chemical reactions that release electrons into the external circuit.
CATHODE is the positive electrode of a primary cell associated with chemical reactions that gain electrons from the external circuit
ELECTROLYTE is a material that provides ionic conductivity between the positive and negative electrodes of a cell.
SEPARATOR is a physical barrier between the positive and negative electrodes incorporated into most cell designs to prevent electrical shorting. The separator can be a gelled electrolyte or a microporous plastic film or other porous inert material filled with electrolyte. Separators must be permeable to ions and inert in the battery environment.
OPEN CIRCUIT VOLTAGE (VOC) is the potential difference across the terminals of the battery when no current is being drawn
CLOSED CIRCUIT VOLTAGE is the voltage of a cell or battery when the battery is producing current into the external circuit.
PASSIVATION is the formation of a surface layer which impedes the electrochemical reactions at the electrodes.

CYCLE LIFE is a measure of the ability of a secondary battery to withstand subsequent charge/discharge cycles. It usually describes the number of charge/discharge cycles that give rise in a battery to the capacity fade at a fixed percentage of the original capacity (usually 80 %). Cycle life depends on the working conditions (e.g., charge/discharge rate).

SHELF LIFE is the period of time over which a battery can be stored and it still meet specified performance criteria without significant deterioration. SELFDISCHARGE is the loss of capacity of a battery under open-circuit conditions as a result of internal chemical reactions and/or short-circuits.

DISCHARGE is an operation in which a battery delivers electric energy to an external load.

CHARGE is an operation in which the battery is restored to its original charged condition by reversal of the current flow.

INTERNAL IMPEDANCE is the impedance that a battery or cell offers to alternating current flow at a given frequency.

INTERNAL RESISTANCE is the resistance that a battery/cell offers to current flow.

ACTIVE MASS is the material that generates electrical current by means of a chemical reaction within the battery.

The SHORT-CIRCUIT CURRENT is of interest especially for larger stationary batteries, since it stands for the maximum current that could be supplied by the battery for a short period of time.

SELF-DISCHARGE means gradual loss of charge in the positive and/or negative electrode, when the battery is stored at open-circuit.

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