



TRANSPORTATION NORDIC

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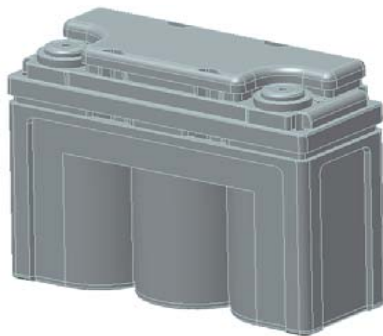
Lead acid batteries in micro hybrid and Hybrid Electrical Vehicle applications

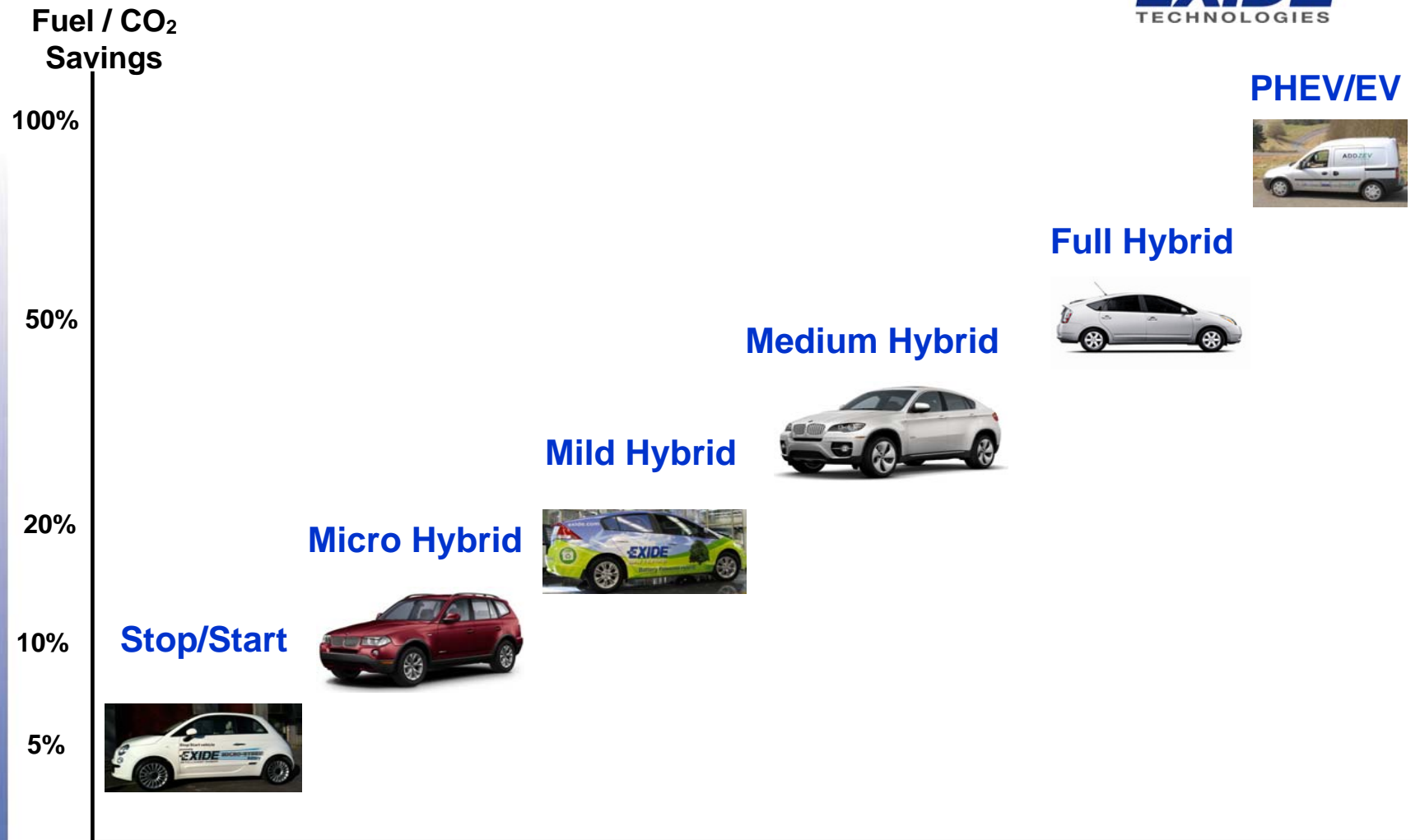
Christer Svensson, Product Manager

January 21, 2011



Lead acid batteries have served their duty to start cars for more than 100 years





Typical battery size

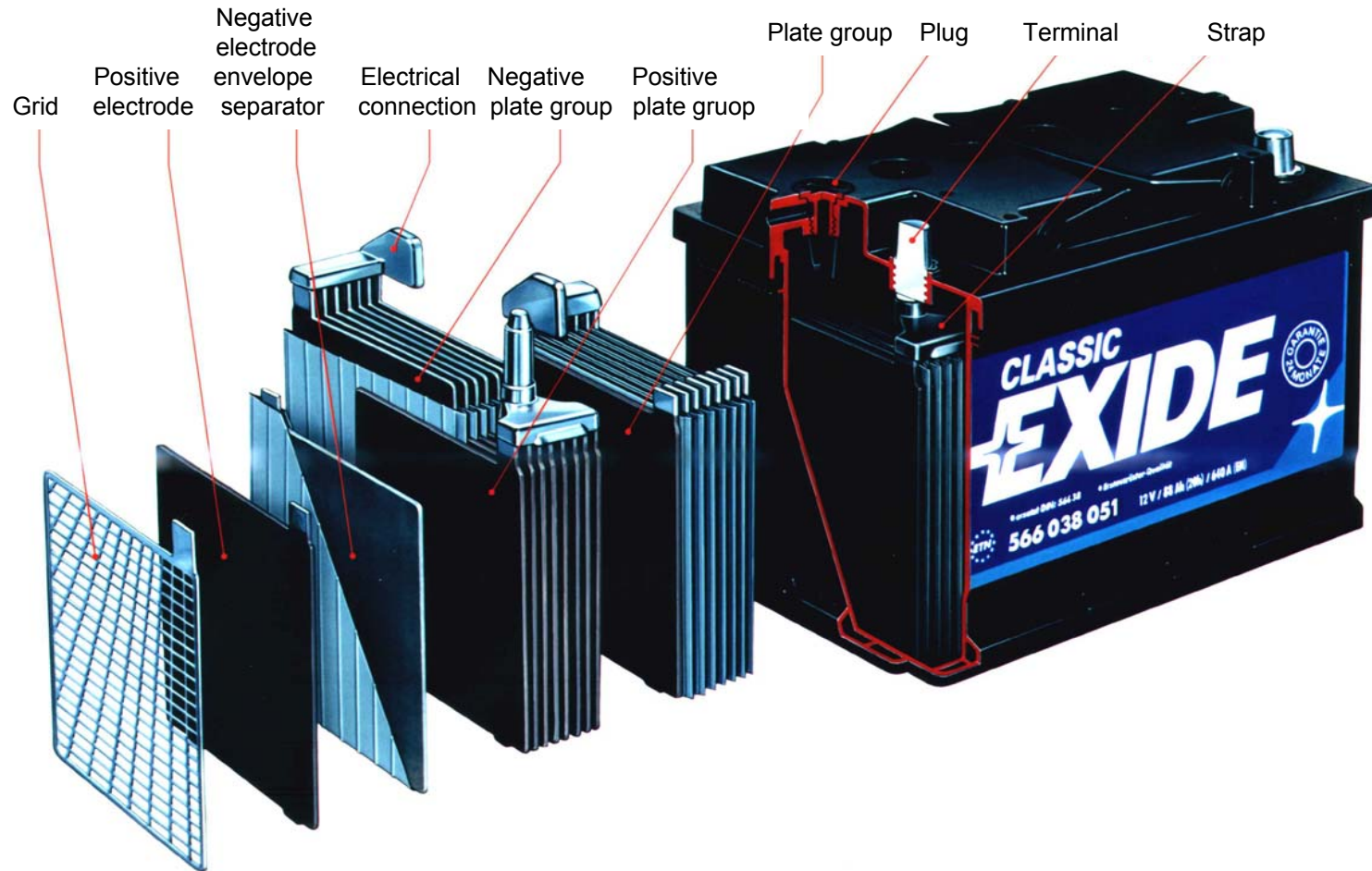
Voltage	12 V	12 V	36 – 100 V	100 – 200 V	200 – 300 V	300 – 500 V
Power	3 kW	4 kW	10 kW	20 kW	40 kW	60 kW →
Energy	0,75 kWh	1 kWh	1 kWh	1,5 kWh	2 kWh	10 – 60 kWh

Lead acid battery base

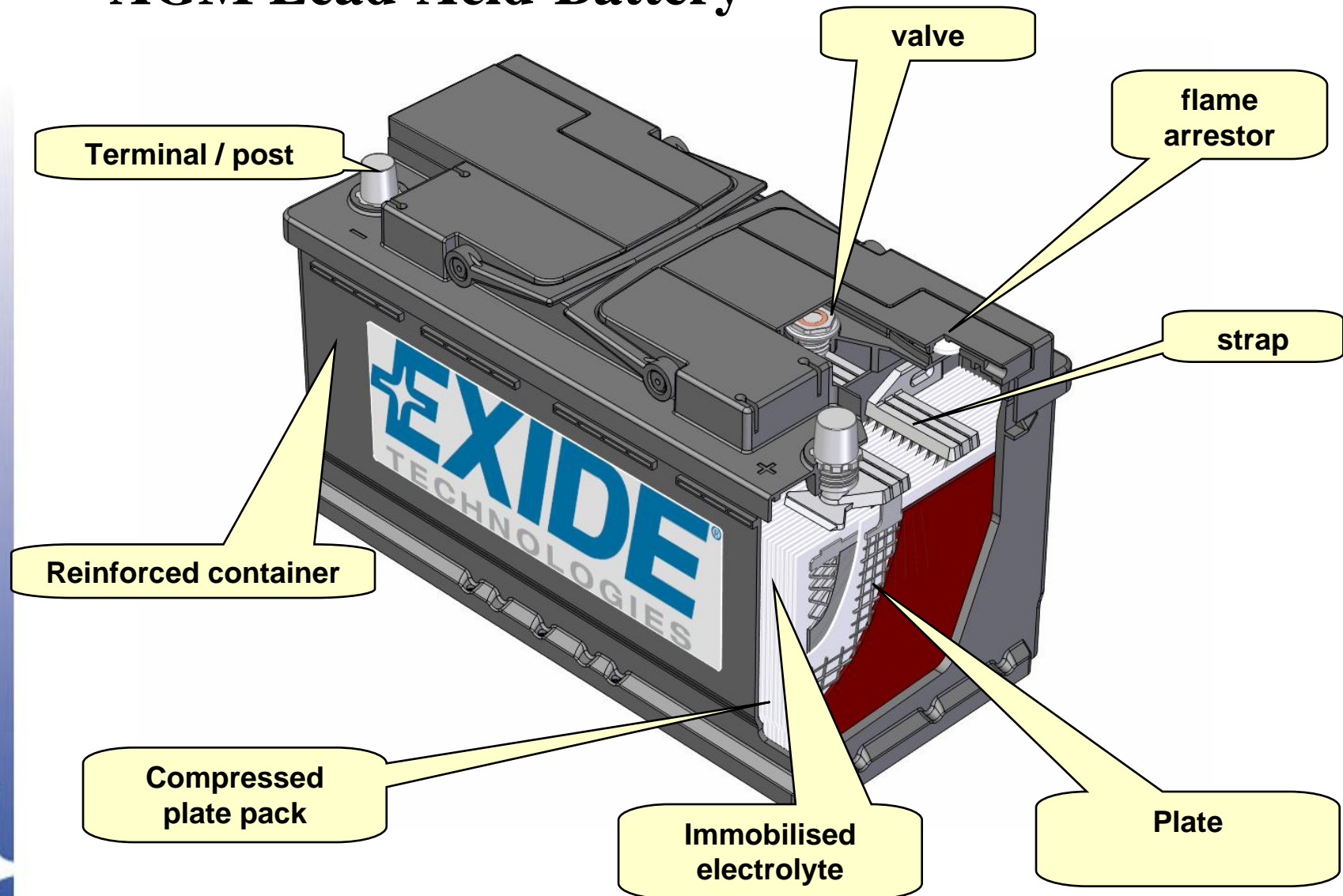


• Manufacturing	Excellent
• Collection/recycling	Very good
• Safety	Very good
• Reliability	High
• Cost	Low (100€/kWh)

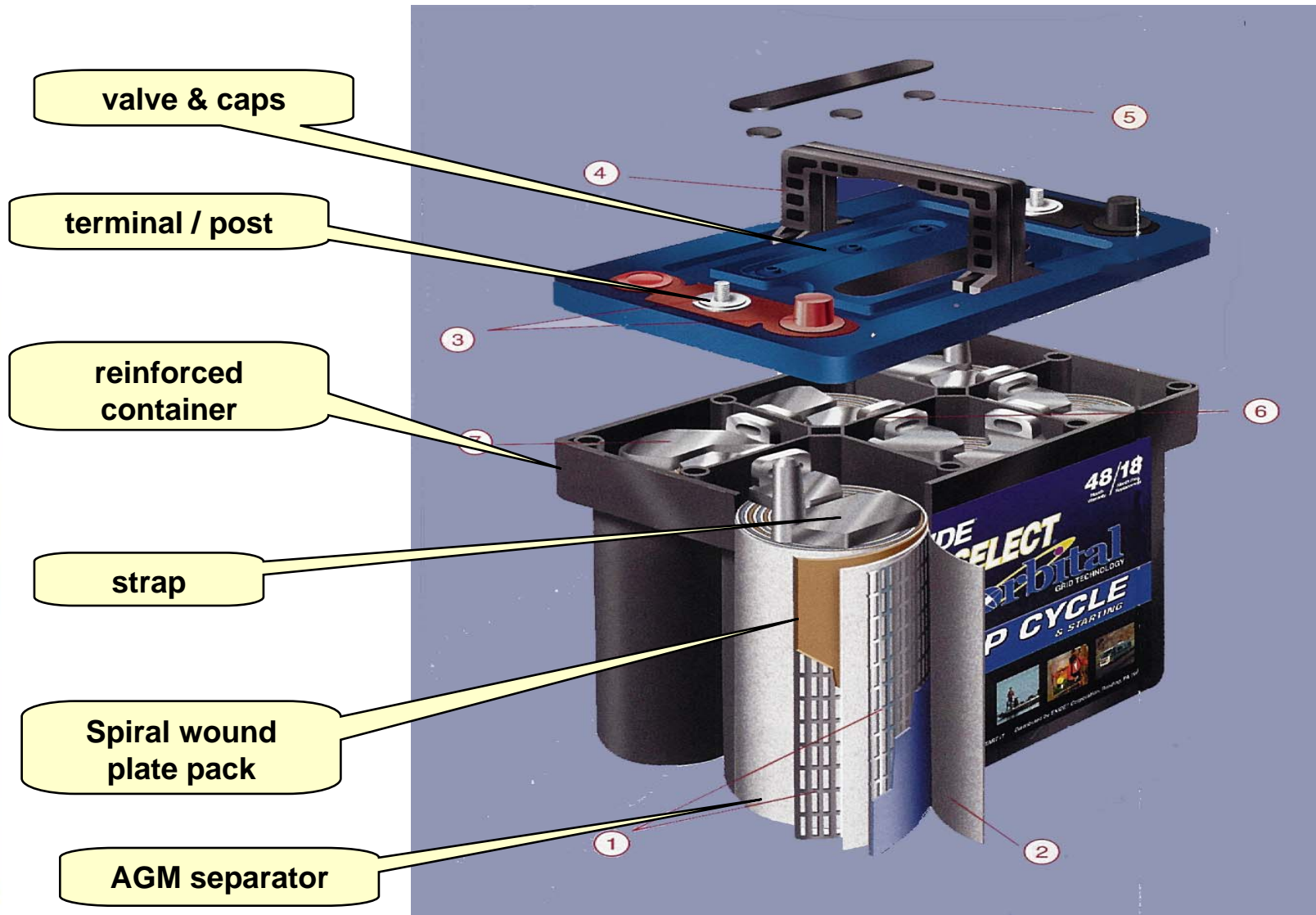
Build-up of a standard lead acid battery



AGM Lead-Acid-Battery



Spiral Wound Battery Design



Challenges – Micro hybrid applications

Micro hybrid applications demand a more active battery operation.

Main differences between standard SLI and hybrid use:

- higher energy throughput
- increased power requirements
- battery working in Partial State of Charge.

Solutions for Microhybrid Vehicles

- Microhybrid = Stop & start / regenerative braking
- Shallow cycling and starting function requirements
- Lead Acid batteries are the most effective solution for these applications due to availability, cost and cold cranking demands.
- Improved versions of flooded design or AGM technology are used depending on power requirements, battery location (engine or trunk) and use of regenerative braking.



AGM ABSORBENT GLASS MAT
TECHNOLOGY

AGM – the premium solution

ECM ENHANCED CYCLING MAT
TECHNOLOGY

MHF – engineered to purpose



Electrical performances- standard LA

- **Discharge power:** Typically 400 W/kg battery
- **Charging power:** Typically 250 W/kg battery
- **Energy content:** Typically 30 Wh/kg - 2 hours discharge

Batteries in HEV are small (1 - 2 kWh)

Power density of standard lead acid batteries needs to be increased for use in HEV applications!

Key is to increase surface area on active materials, reduce weight and inner resistance.

Development for Hybrid Electrical Vehicles - HEV

Examples of running projects on lead acid batteries for reduced weight and improved performances to suit Hybrid Electric Vehicle applications

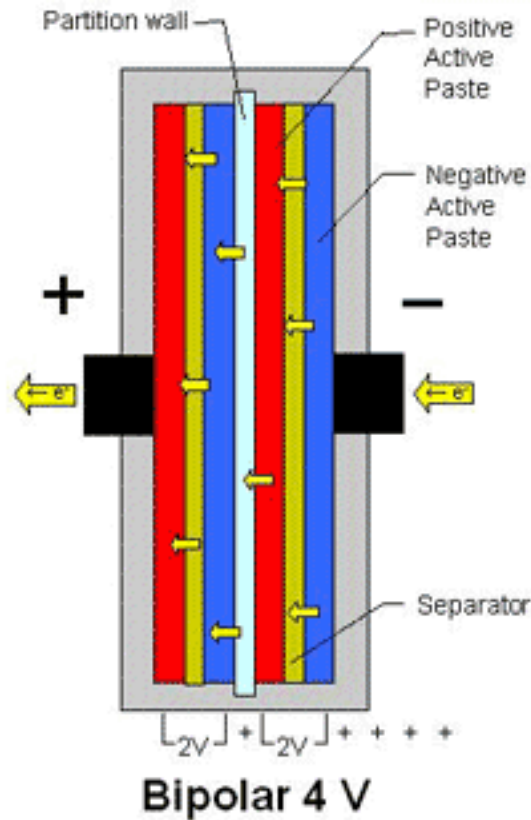
Lead-Carbon battery

Bipolar battery

Combination supercapacitor/battery

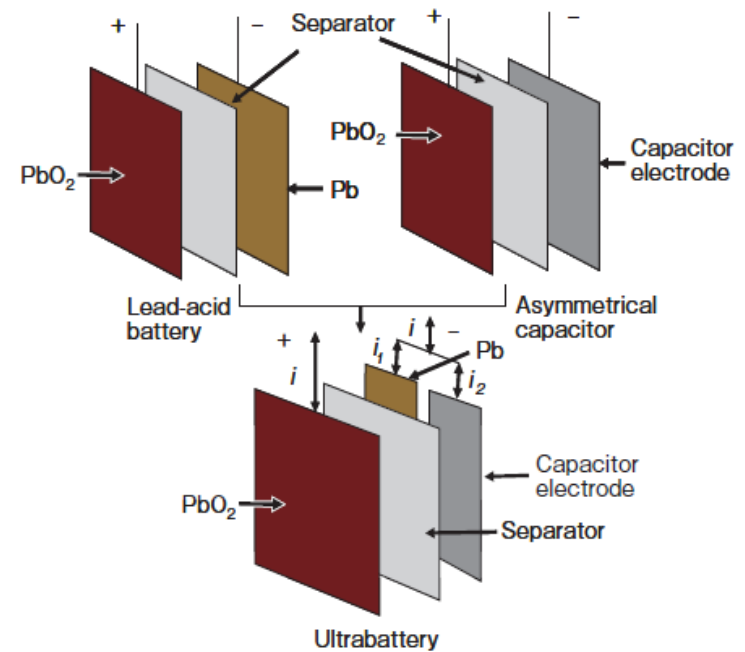
BIPOLAR DESIGN

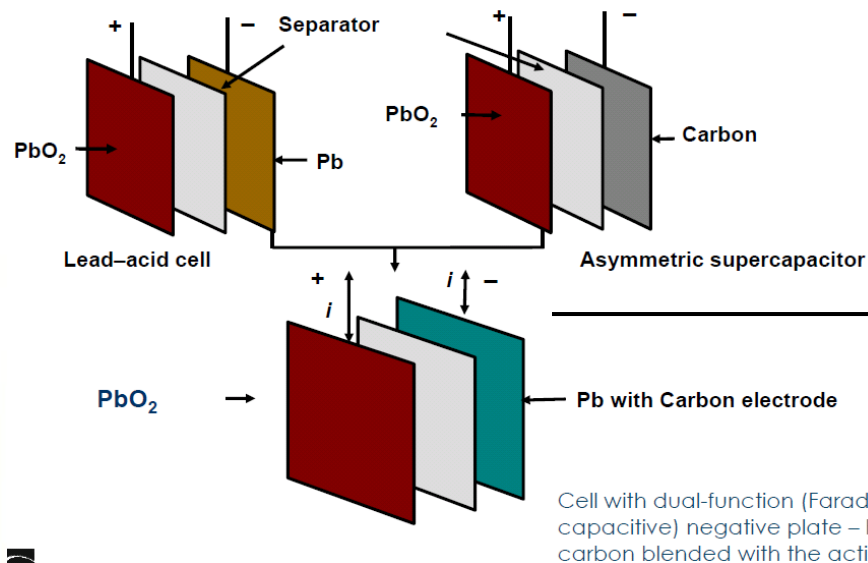
Chemical charge



BATTERY/CAPACITOR

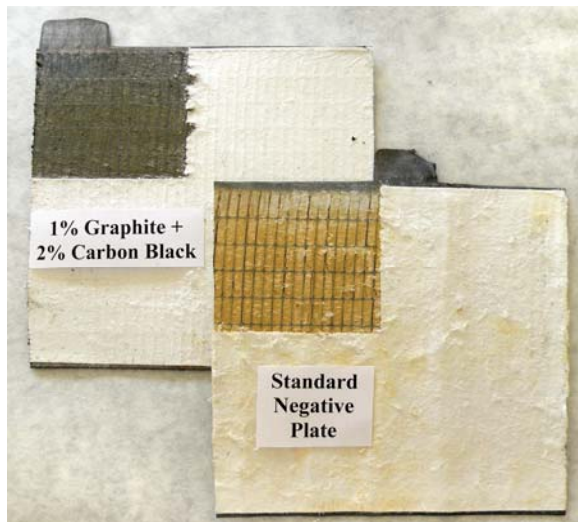
Chemical/Superficial charge





Lead Carbon battery using a combination of lead acid cell and a supercapacitor.

Lead Carbon battery using Carbon blended into the negative active material.



Addition of high surface area carbon

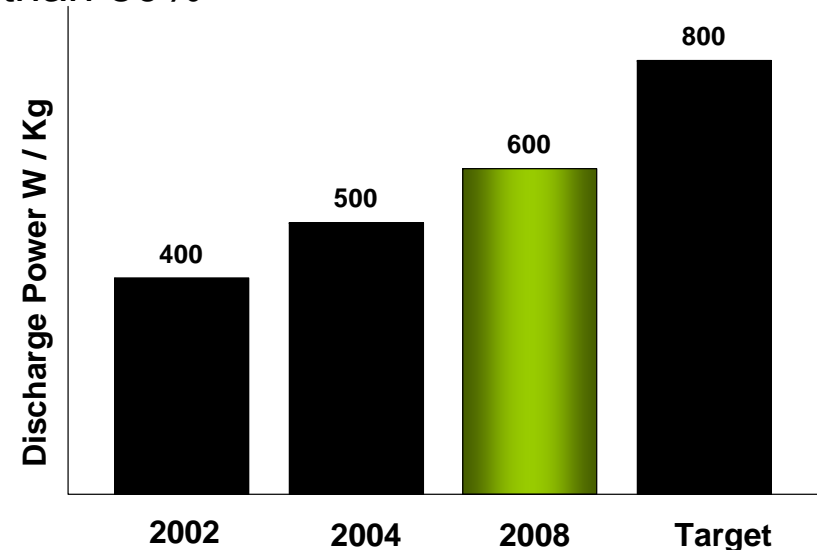
- Up to 3% by weight
- Equivalent to 15% by volume
- More than 80% increase of surface area

Power Performance Evolution

Lead- Carbon battery

Test results obtained on Lead Acid batteries with addition of High Surface Area Carbon

- Addition of up to 3% by weight in negative active material
- Equivalent to 15% by volume
- Increases surface area by more than 80%
- Target is to reach 800 W/kg



EXIDE ADVANCED BATTERY HONDA INSIGHT

Battery Modules:

- Prismatic AGM with carbon additives
- Power Density - 400 W on charge/kg at 60% State Of Charge
- Energy Density - 31 Wh/kg C_{20} Capacity - 12 Ah
- Weight - 4.7 kg/battery

Battery Pack:

9 battery modules

54 Cells at 2V - 108V

Total pack weight 43 kg

Advanced Carbon Lead Acid Battery – 108V/10kW



- Carbon Lead Acid Flat Plate AGM battery with thin, high surface area electrodes.
- Next generation will have even thinner electrodes and its advanced design will incorporate more innovative additives such as porous hollow microspheres in the positive active material. These cells will have a power density close to 800 W/kg and is in development now. Field testing in hybrid vehicles is scheduled for 2011.

