Eternity TECHNOLOGIES

New Generation Lead Acid Batteries –

Advancements in Achieving Ultra-Low Internal Resistance in Lead Acid Batteries

21th Asian Battery Conference – Sept 2025

Kota Kinabalu, Malayasia

Nano Carbon Motive Battery

QUASAR HIGH ENERGY ON DEMAND

About Eternity Technologies

THINK GREEN THINK ETERNITY

Founded in 2011 by Al Dobowi Group in Ras Al Khaimah UAE, Eternity Technologies is one of the fastest growing industrial battery companies.

With state of the art global and regional manufacturing locations, Eternity Technologies has 2 major factories in United Arab Emirates but also operations in Germany, Spain, USA, South America and South Africa to best serve the Motive and Reserve power markets. The Company Sells to over a 100 countries worldwide offering a wide range of industrial Batteries and services

Our Mission:

To deliver the most **Reliable, Sustainable and Available Battery Solutions** to the industrial battery market.

How we do it :

Our products are designed and manufactured with the most **advanced technologies** resulting in **high performance, maximum life** and **minimum carbon footprint.**

We have a unique global and regional manufacturing operation which allows us to have the **Best Flexibility and Delivery Leadtime** in the industry.

Manufacturing & Certifications

Product & Process designs developed from European technology:

- All production machines & processes procured from European suppliers & to world-class technology levels
- All specialised materials & components procured from Europe
- High degree of local sourcing for raw materials

The factories meets the most stringent, international standards for:

- Health & safety
- Quality
- Environmental Management
- Accredited laboratories
- Eternity is member of EUROBAT
- Environmental, Social & Governance Journey (ESG)

Eternity Technologies is recently awarded with ISO 50001 for Energy management Systems

Why Ultra-low Internal Resistance Matters?

Eternity TECHNOLOGIES

EuroBatt Innovation Road Map 2035

- Key areas for innovation are improvement in Life time, Higher material Utilisation and Increase Energy density.

- The General Technical requirements for Batteries (for material handling application) are high charge and discharge rates, high Energy content, cycle life and Operating times, high recyclability, low investment cost and the need to meet strict safety requirement.
- As far lead acid batteries, lowering the TCO is Key. This can be done by increasing the cycle life, reducing the recharge time, as well as producing maintenance free batteries

Source – EUROBAT - Battery innovation Road Map. Version 3 June 2024

Objective and Metrics

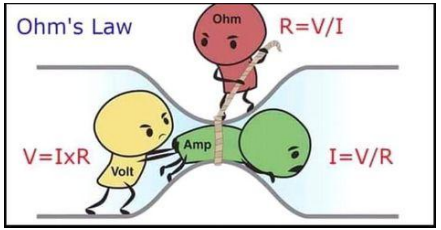
- Higher Energy Efficiency
- Lower heat Generations
- Supports Fast charging
- Enhances High Rate Discharge (HRD) performance
- Improves Cycle life (particularly in PSOC operation.
- Enhances Operational Cost Savings

Ultra Low internal resistance is the key to achieve this Objective and metrics

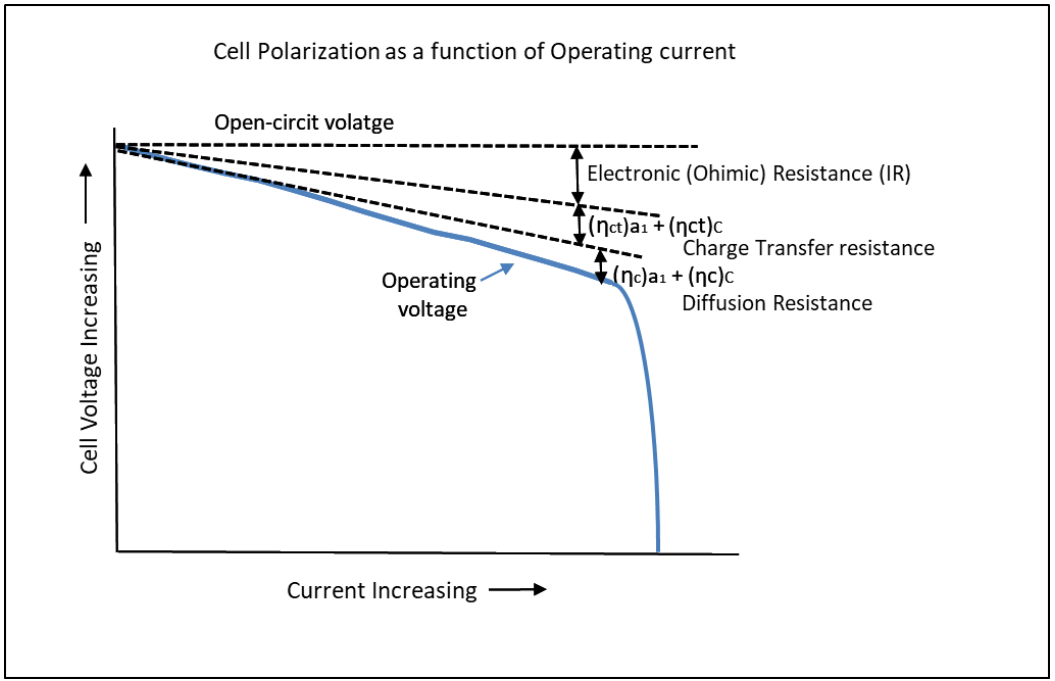
Internal Resistance – Core Concepts

- Internal resistance (IR) of a battery is defined as the opposition to the flow of current within the battery.
- There are two basic components that impact the internal resistance of a battery; they are electronic (Ohmic) resistance andionic resistance.
- The electronic (ohmic) resistance - Resistivity of the actual materials such as the Grid/Active material and internal components such as Separator; as well as, how well these materials make contact with each other.
- Ionic resistance is the resistance to current flow within the battery due to various electrochemical factors such as, electrolyte conductivity, ion mobility and electrode surface area. This is further classified into the below 2 category

  - ✓ Charge Transfer Resistance
  - ✓ Diffusion Resistance



Internal Resistance – Core Concepts



RCT- Charge Transfer Resistance

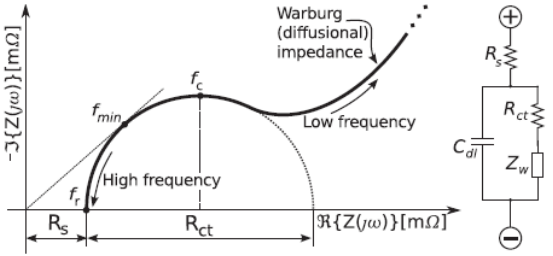
Cdl – Double layer capacitance

Zw – Warburg impedance due to ion diffusion in electrolyte and pores of the electrode

Rs – Ohmic Resistance (connections, separator, electrolyte resistivity and surface coverage of electrodes by crystalized lead sulphate

Factors affecting Internal resistance

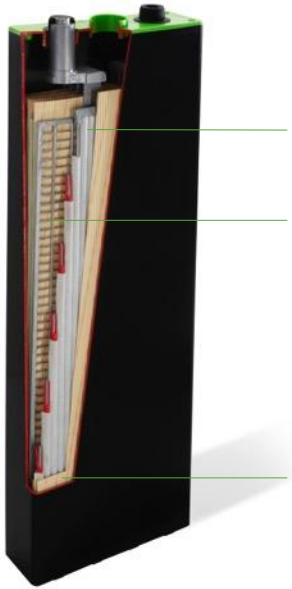
- Choice of Materials such as alloy, separator, gauntlet etc.
- Design and thickness of grid and current collecting element
- Conductive Additives
- Space between plates / Separator thickness



Design Improvements – Ultra low IR

CNT
TECHNOLOGY

CNT (Carbon Nanotube) Technology is a modern alternative to activated carbon / Graphene. Carbon Nanotubes increase the negative plates fast charge capability. The Carbon Nanotubes work as conductors to the charging current and accepts charge easily with little resistance



Positive plate with thin tube technology

Negative plate made with Carbon Nanotube (CNT) Technology.

Phenolic resin separator

Different than standard PZS separator, this separator is used due to the heavy-duty operating demands places on the QUASAR product.

All result in an ultra low resistance battery

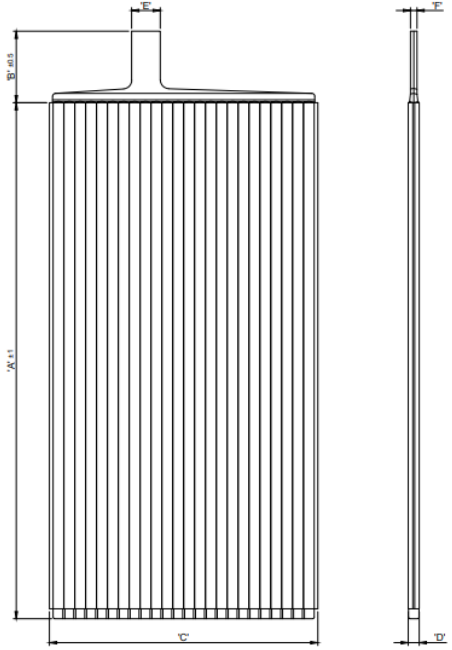
Positive Plate with Thin Tube Technology

- Thinner Plates
- 24 Tubes Vs 18 Tubes
- Specific Energy – 42 Wh/Kg Vs 34 Wh/Kg
- Energy Density – 110 Wh/Litres Vs 90 Wh/Litres

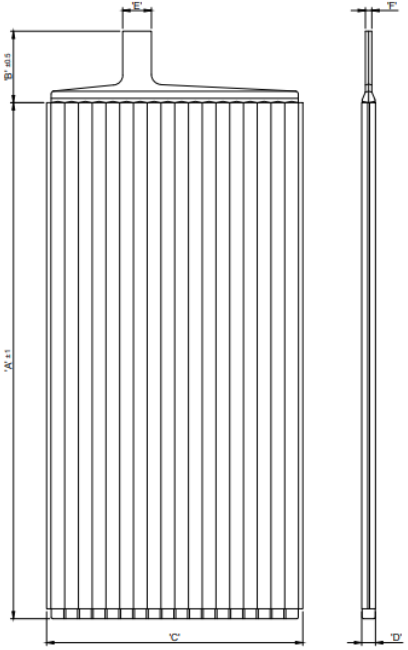
Advantage of Thinner Plates

- More number of plates
- Increased surface area
- Rapid electrolyte diffusion

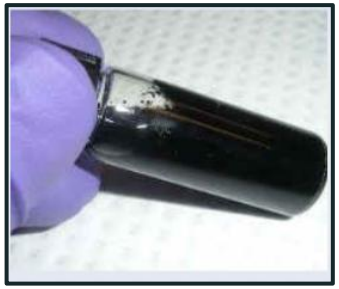
QUASAR POSITIVE PLATE



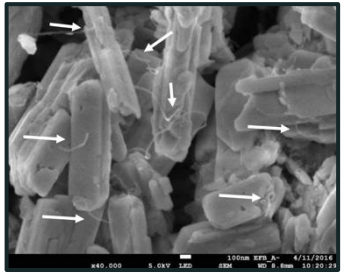
DIN POSITIVE PLATE



About Carbon Nano Tube Technology



- Eternity Technologies uses patented **MOLECULAR REBAR®** Carbon Nano Tube Fluid from **Black Diamond Structures** in a specific battery paste mixing process.



- It creates a network of individual nanotubes allowing for electrons to flow with minimal resistance, as well as reinforcing the plates, adding lasting strength and durability

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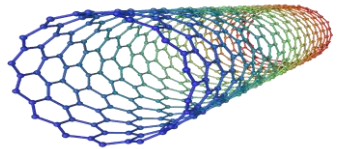
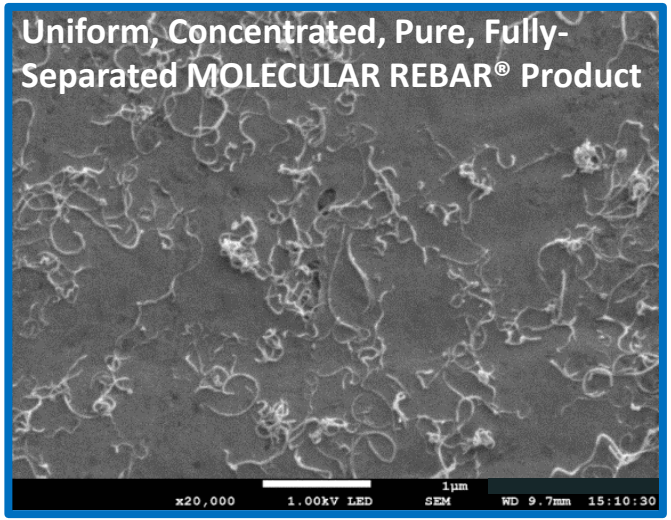
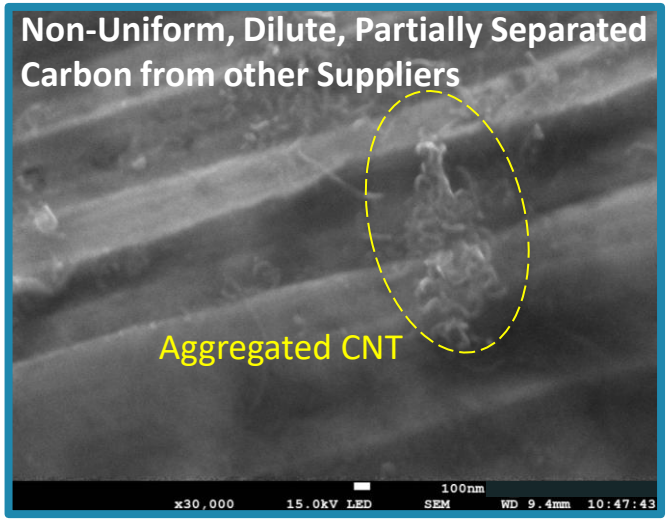
- Enhances Consistency of Performance
- Improves Charge Acceptance
- Increases Cycle Life
- Enables Partial State of Charge Operations (PSOC)
- Improves Thermal Operational Ranges



About Carbon Nano Tube Technology

- MOLECULAR REBAR® delivers **uniform, concentrated, and fully separated nanotubes**, ensuring consistent performance and reliability in batteries.
- Competitors often supply non-uniform, diluted, or aggregated materials that compromise consistency between batches, conductivity, and durability.
- Backed by **3rd-party validated performance , strong IP protection, and cost efficiency**, MOLECULAR REBAR® uniquely balances quality and value—making it the most trusted nanomaterial for next-generation lead-acid and advanced batteries.





Low Electrical Resistance Separator

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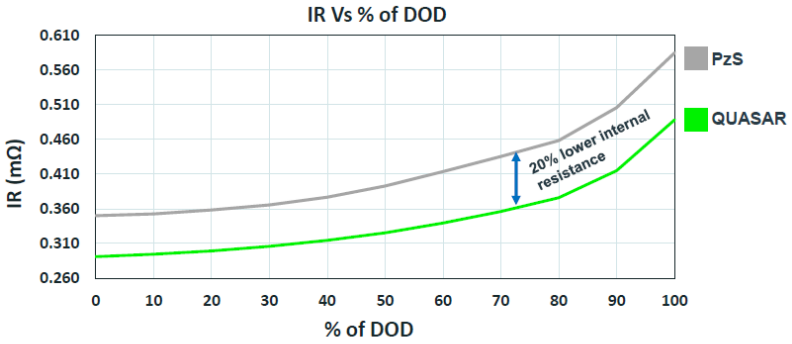
Industry leading phenolic resin separator gives:

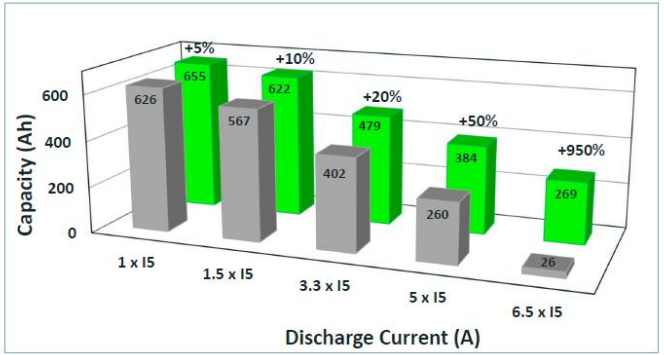
- Higher porosity leading to higher electrolyte volume resulting in higher energy density.
- Minimal electrical resistance
- Excellent oxidation resistance

SR. NO.	DESCRIPTION	PzS	QUASAR
1	Porosity (%)	50 - 55	70 - 75
2	Acid Displacement (ml/m^2)	260	160
3	Electrical Resistance (mΩ.cm2)	350	80
4	Material	PE (Polyethylene)	Phenolic Resin & polyester mat
5	Overall Thickness (mm)	1.90	1.15

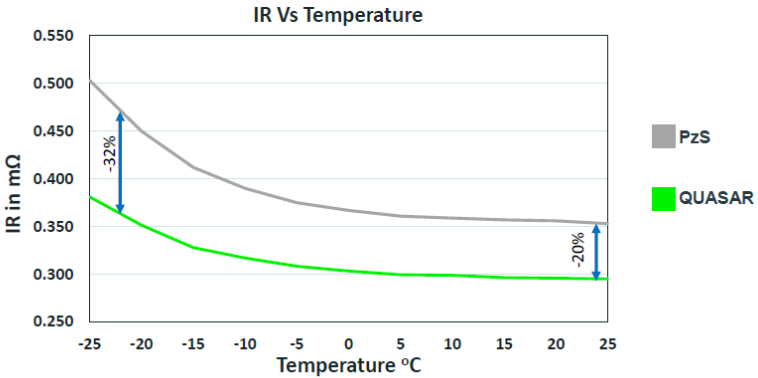
Internal Test Results



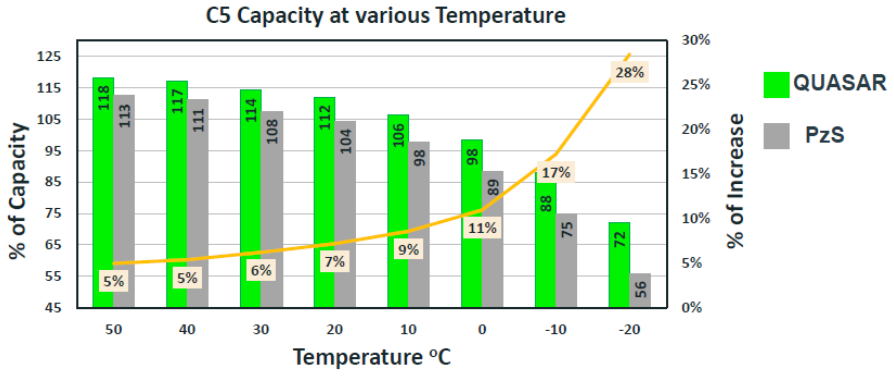
The IR of Quasar product is 20% lower than that of the standard PZS.



Excellent behaviour at high rates of discharge

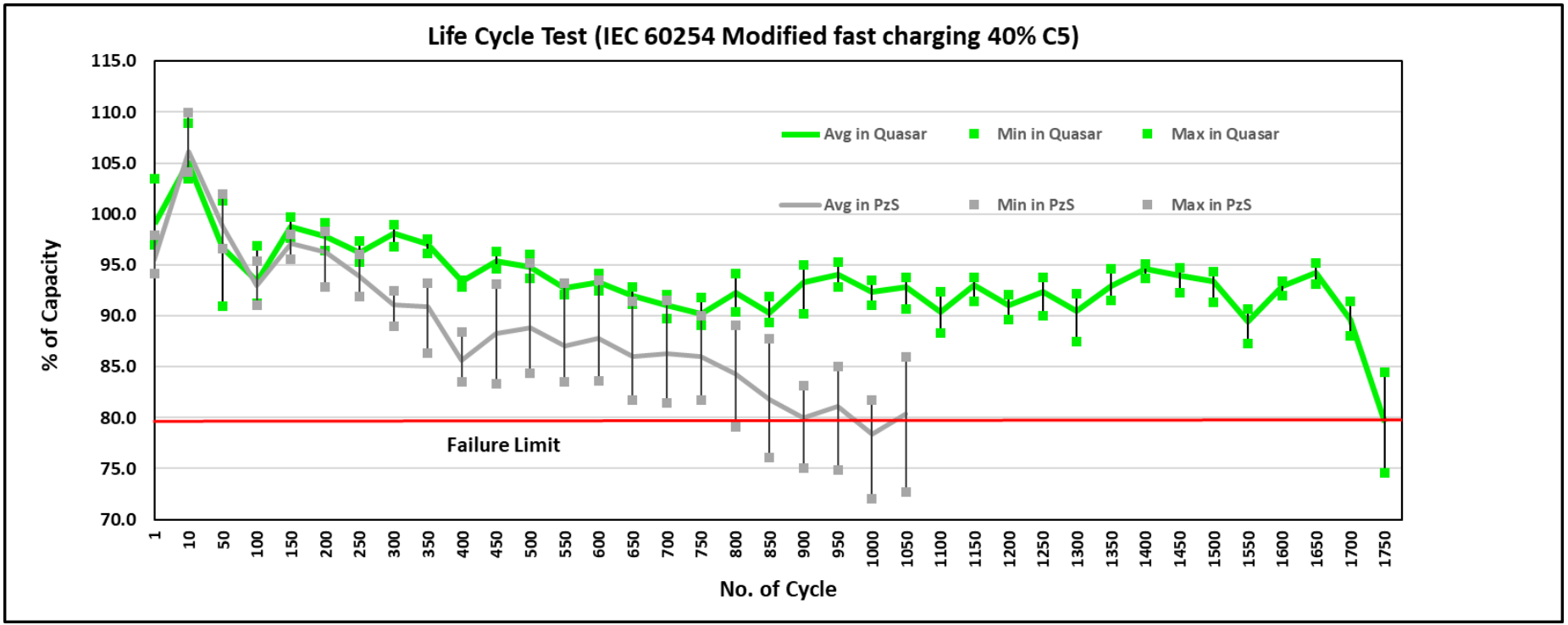


At Lower Temperature Quasar product has upto 30% lower IR than that of PZS



Greater capacity available at lower temperature, e.g. cold stores

Quasar Life cycle_ With Modified Fast Charge Profile



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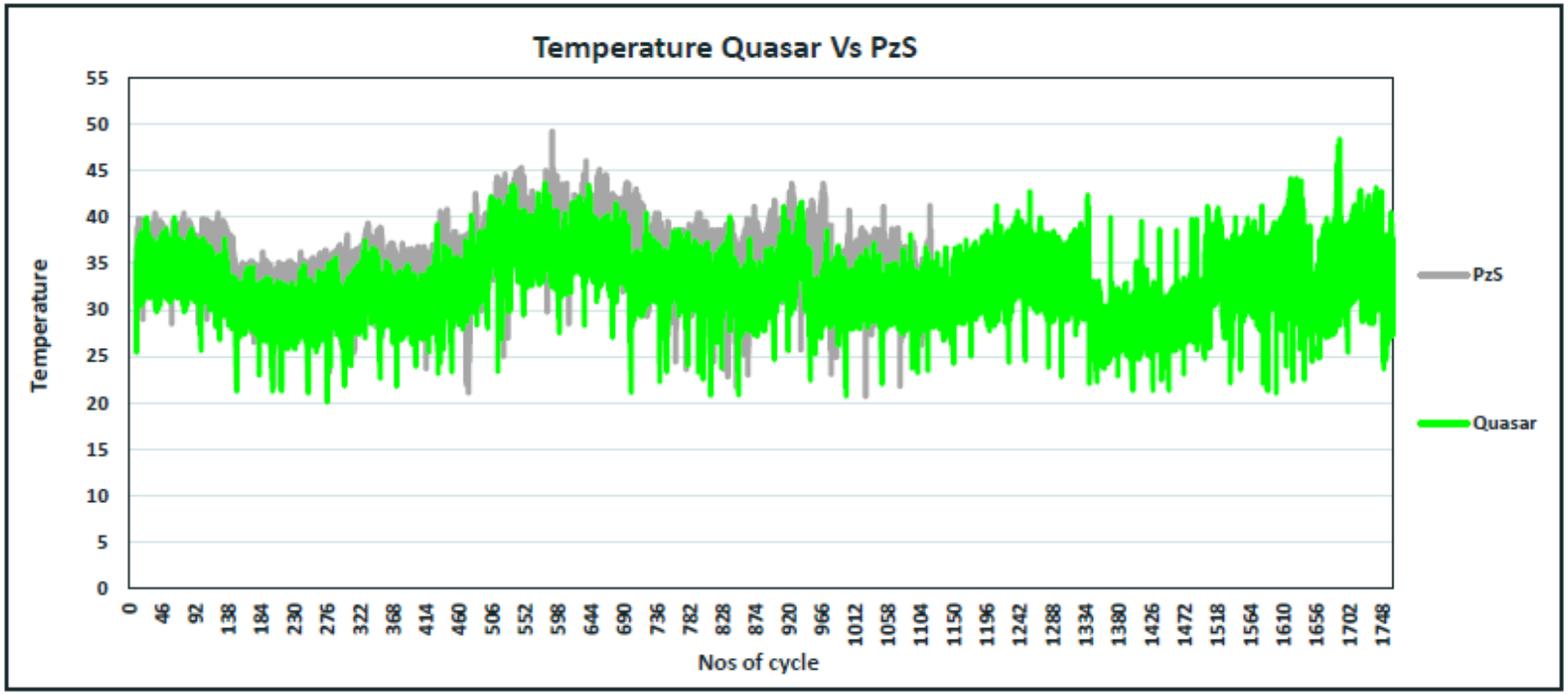
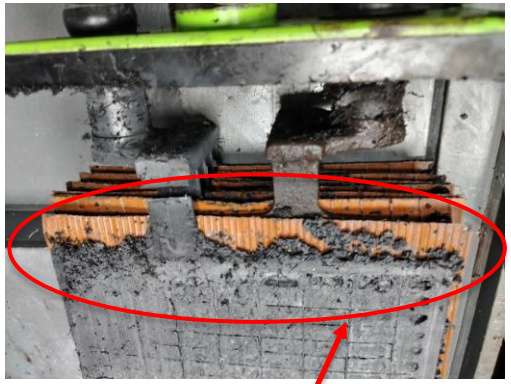
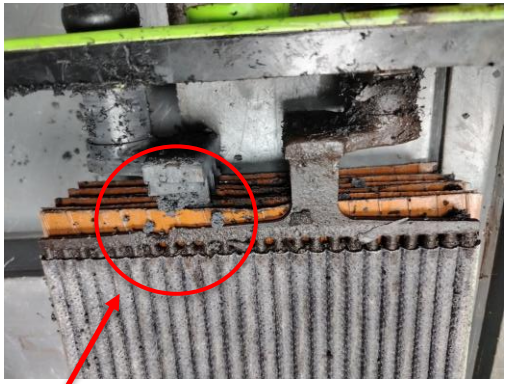


Lower internal resistance results in 8 - 10°C reduction in electrolyte operating temperature.

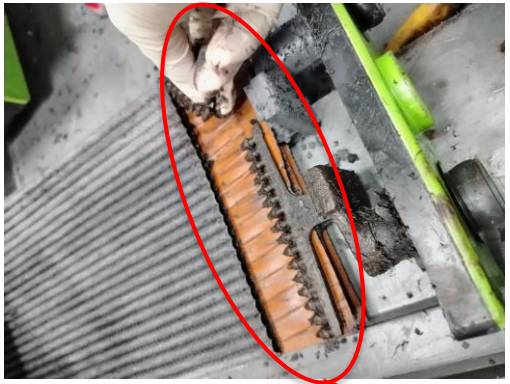
Learning from the tear down analysis – after 1750 cycles



NAM Mossing



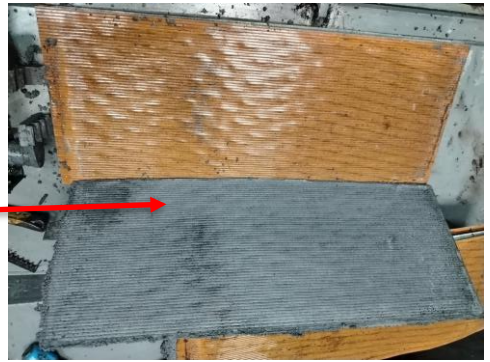
Top Short due to NAM Mossing and frame crack



Spine corrosion on Carrot area

Spine Core is still intact

Separator and Negative Plates – Still in good condition



Failure Mode analysis

Positive Plates

- Frame Crack – caused predominantly by NAM mossing
- Spine corrosion – Near carrot area results in detachment of top frame from the rest of the plate
- Spine Core, Gauntlet – Still Intact
- Positive AM – Though some softening observed, the integrity of Active material is still good.

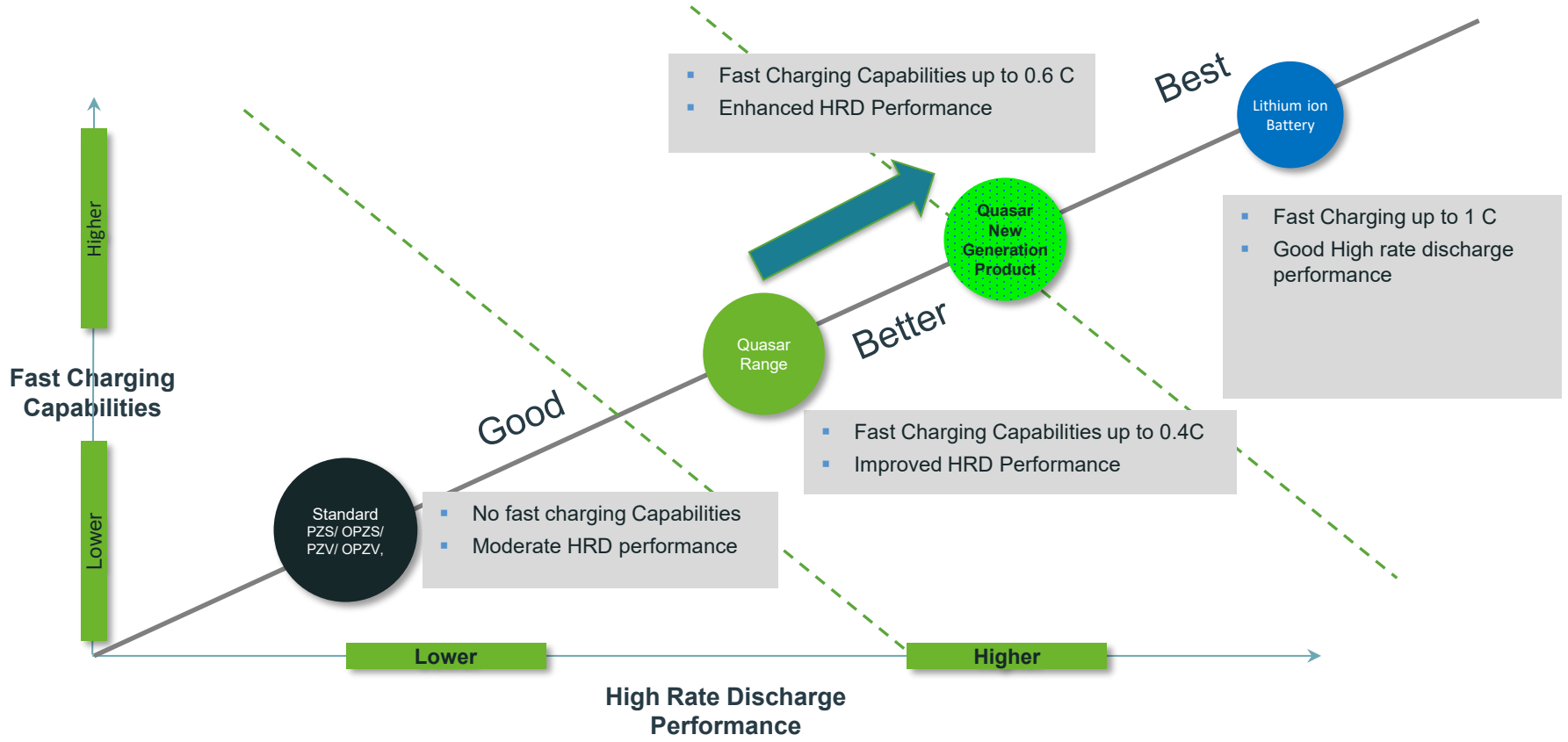
Negative Plates -

- NAM Mossing – resulted in Top short
- NAM – Expansion observed, which is typical for the cells that are cycled 1800 cycles.

POSITIVE spine corrosion (near carrot area) and short caused by NAM mossing are the main Failure modes.

By addressing the Failure modes in the New Generation Quasar, the life cycle performance will be further improved.

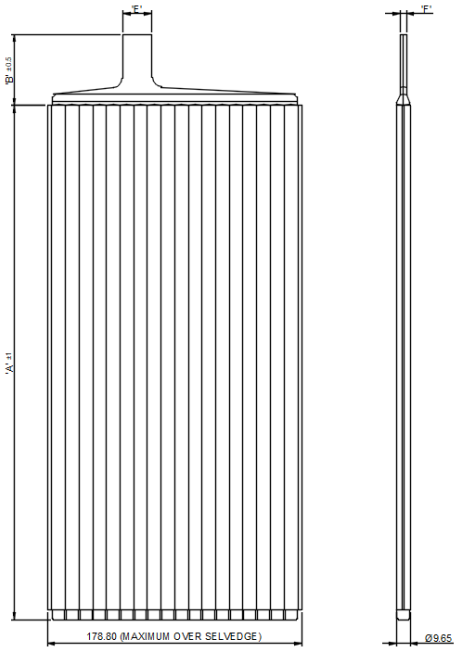
Product Positioning – Bridging the gap LAB Vs LIB



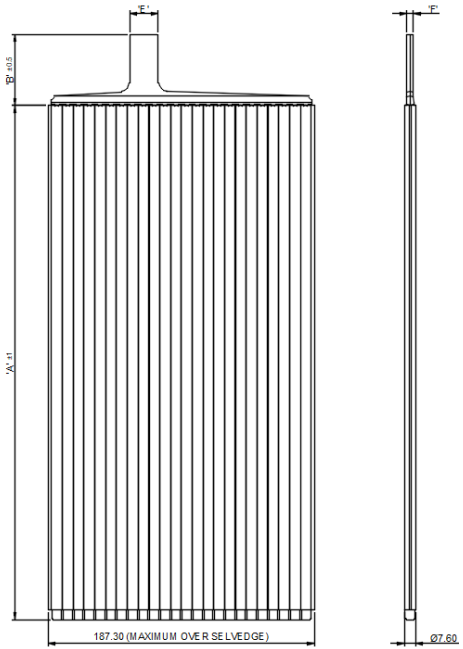
Eternity Product Evolution

PZS → **Quasar** → **Quasar - New Generation Product**

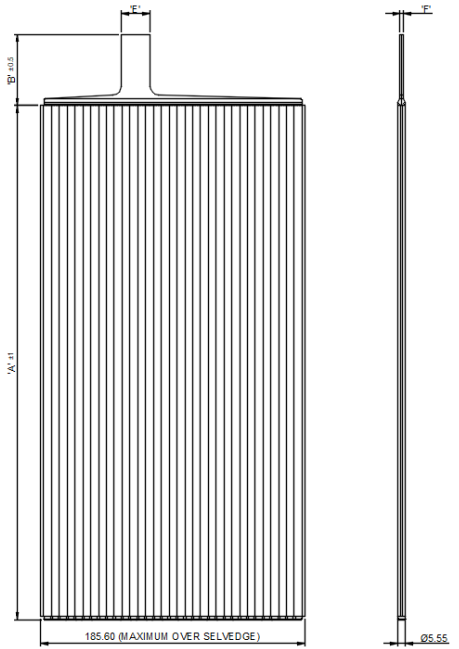
DIN POSITIVE PLATE



QUASAR POSITIVE PLATE



33 TUBE THIN POSITIVE PLATE



Eternity Product Evolution

Eternity TECHNOLOGIES

DESCRIPTION	PZS	QUASAR	New Generation (Quasar Plus)
SPINE DIA, mm	Ø3.15	Ø2.75	Ø1.80
GAUNTLET INNER DIA, mm	Ø8.35	Ø6.30	Ø4.55
NUMBER OF TUBES	18	24	33
Overall Plate Thickness, mm	9.65	7.60	5.55
Separator Thickness, mm	1.90	1.15	0.9
Specific Energy Wh/kg	34	42	48
Energy Density Wh/liter	90	110	125

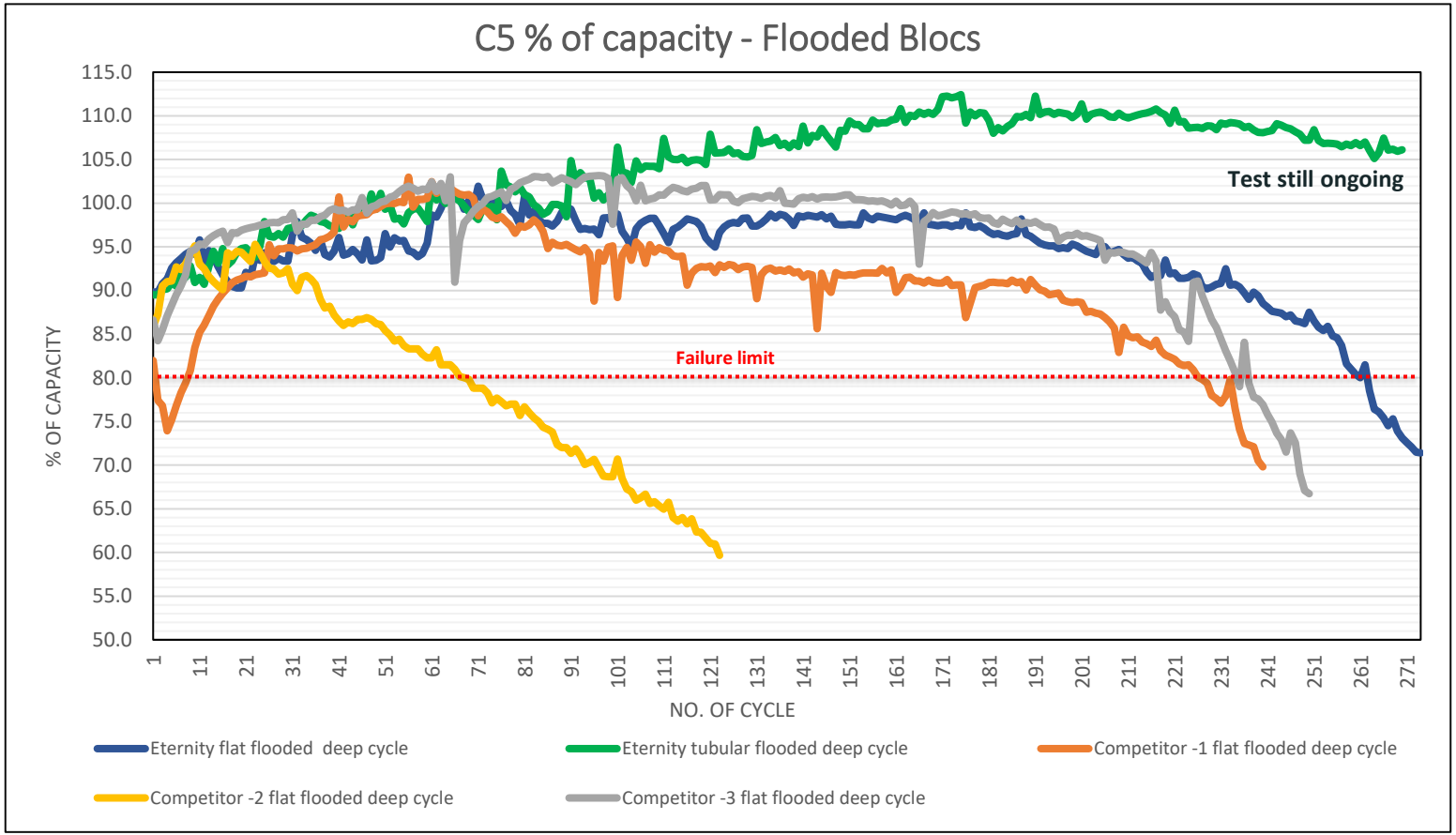
Advanced Manufacturing techniques and Material Science

Focus Areas

1. Innovative Manufacturing Technologies.
2. Advanced material Sciences –Every components of cells are addressed

Components	Focus Area	Key Benefits
Spine	Wire Extrusion and Advanced Welding Technology	No Phase transfer and minimizes internal defects,. Smaller Grain Structure and better corrosion resistance
Positive Plates	Slurry Filling	Improved packed density and reduces plate damages (no risk of Spine bend), Allows to fill smaller diameter tubes.
Gauntlet	Edgeless/ Conductive material impregnated Fabric	Allows space for more electrolyte, Improved Electrical conductivity, Reduces Oxidation, Improves cycle life
PAM performance Enhanced Additives	Tetrabasic Seed crystals/Binders/Metal Oxides and Metal sulphates	Improved Active material integrity, gradual development of capacity and Improved Cycle life
Negative Grids	Expanded/Punched Grids	Reduces Weight and increased energy density
NAM Performance Enhanced Additives	Additives that inhibits mossing/conductive additives	Improves conductivity, reduced Mossing and prevents short circuits.
Gel Electrolyte	Novel Gelling Agents/ Nano Engineered Gel for improved conductivity	Improved conductivity and enhanced ionic diffusion.
Pillars/ current collectors	Low resistance geometry/ Advanced Composite conductive materials.	Improved conductivity and corrosion resistance

Life Cycle performance at 100% DOD – Flooded Blocs (Flat Plate Vs Quasar new Gen Quasar Thin Tubular)



Expansion Plan for Testing Labs

Objective:

Enhance R&D Capabilities and Streamline Validation process

Investment Focus: Cutting-Edge Equipment and efficient testing methodology

Analytical lab Equipment

- X-Ray Diffraction Machine (XRD)
- Scanning Electron Microscope (SEM)
- BET Surface area Analyzer
- Mercury Porosity Meter
- Electrochemical Impedance Spectroscopy
- Cyclic Voltammetry
- Bench top Paste Mixer
- Lab Scale Curing Chamber

QUASAR Motive Power Advantages

Delivering increased performance in energy demanding applications.

- **Thin tube technology** giving high energy density and excellent high-rate discharge performance
- **Carbon Nanotube Technology** provides greater charge acceptance vs conventional lead acid batteries
- **2X Faster Charging** allows opportunity charging and eliminates the need for battery changes
- **Increased run time** vs conventional battery gives up to 25% more truck hours
- **Extreme Temperature performance** makes it ideal for cold storage and outdoor application with runtime up to 50% more than PZS
- **Energy Saving –** Low internal resistance saves operational cost by maximizing efficiency and minimizing heat loss during charging/discharging.
- **Lower Carbon Footprint –** Reduces end user carbon footprint
- **Reduction in battery capital expenditure**

Driving True Battery Innovation

Our Mission is not simply to evolve existing battery technologies, but to drive real and transformative innovation. Through bold new approaches to material sciences and advanced manufacturing we are redefining the energy storage solutions.

This is not just a product Evolution. But real **Product innovation**

Eternity TECHNOLOGIES

Thank You for Your Attention

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