Batteries Na-ion pour applications haute puissance

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CTO Tiamat

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CREATION OF THE RS2E FRENCH NETWORK IN 2012

CREATED BY FRENCH MINISTRY OF RESEARCH AND INNOVATION & CNRS

17 laboratoires de recherche

Amiens, Bordeaux, Caen, Evry, Grenoble, Lille, Marseille, Montpellier, Mulhouse, Nantes, Orléans, Paris, Pau, Toulouse

13 partenaires industriels

3 EPIC (centres de transfert)

Partenaires institutionnels :
Ministère de l'Enseignement Supérieur, de la Recherche et de l'Innovation (MESRI), CNRS et Universités

CREATION OF THE RS2E FRENCH NETWORK IN 2012

CREATED BY FRENCH MINISTRY OF RESEARCH AND INNOVATION & CNRS

OBJECTIVES

- **Solve the scientific and technological bottlenecks in electrochemical storage systems (batteries, supercapacitors) for mobile and stationary applications**
- **To develop French expertise in the field**
- **To improve technology transfer from research to industry**

1 topic among others : Na-ion

- **Uncertainties over lithium reserves / Fluctuating costs**
- **Sustainable development**
- **Lower costs ?**

CNRS / UPJV Facilities : Energy Hub Pre-transfert Platforms

Synthesis of new materials

Upscale promising materials

Study cells at the commercial scale (preindustrial 18650 prod. facility)

Electrode coating | calendering | cutting | Filling and sealing

winding | Echem testing

Dry room

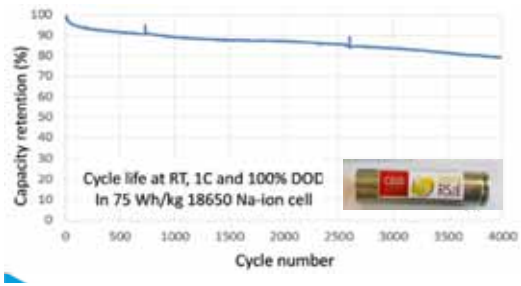
Developed Sodium-ion Technologies by Tiamat

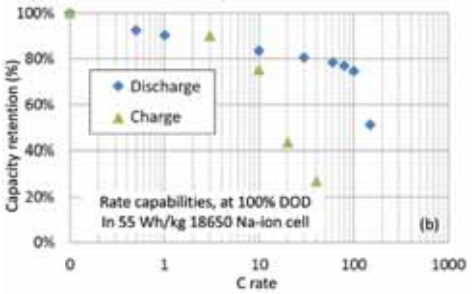
Gen² TR 4

Gen¹ TRL 8

PROJECT HISTORY

- Launch of the project by ALISTORE in 2011 with a PhD thesis
- Boosting research at RS2E in 2012
  → Interesting and promising results
- Carbon Coated $Na_3V_2(PO_4)_2F_3$ // HC





Towards high energy density sodium ion batteries through electrolyte optimization A. Ponrouch, R. et al. Energy Environ. Sci., 2013, 6, 2361–2369

High Rate Performance for Carbon-Coated Na3V2(PO4)2F3 in Na-Ion Batteries T. Broux, et al. Small Methods **2019**, 3, 1800215

=> GEN¹ TIAMAT Sodium-ion technology is a Nickel, Lithium and Cobalt-free product

Our story : from french research to global market

Our story (continued)

TIAMAT is the leading manufacturer of **sodium-ion battery cells** for power applications in portable tools, stationary storage systems and mobility that fulfills unsatisfied Customer needs.

Our ambition is to become the **leading solution for power applications**

NVPF-HC for High Power Market

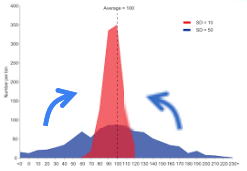
Energy density

2017	2019	2021	2023
55Wh/kg for high power cell and 75Wh/kg for power cell	65Wh/kg for high power cell and 80Wh/kg for power cell	75Wh/kg for high power cell and 100Wh/kg for power cell	One design fits all: 105Wh/kg to 130Wh/kg depending on the cell format

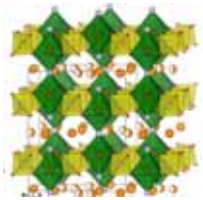
TIAMAT'S Sodium Batteries Performance Evolution

Tiamat is using LRCS prototyping platform since 2018, to :

- Test and improve cell design and chemistry according to Customers' specifications (7 versions until 2018)
- Gain manufacturing know-how and identify critical steps to reduce dispersion (coating thickness, jellyroll drying, formulation, tab to can welding,…)
- Get enough cells for Proof-of-Concept realization
- Cell design (Patent)
- Selected Hard Carbons
- Formulation of Slurries at different scale
- Electrolyte optimisation
- Contracts signed for the Supply chains



Raw materials focus - CAM



- First involvement within the Sodium-ion taskforce
- Direct partnership with Tiamat since 2017
- 10-20kg batches from 2019 to 2023
- 3 tons delivered in 2024
- 40 to 60 tons planned in 2025
- 4 000 tons/GWh are needed

Key takeways :

- Quality validation and evaluation procedures are key during upscale
- Upstream supply chain must be organized as early as possible

ELECTROLYTE : Interface Stability

Symmetric cell studies (25 °C)

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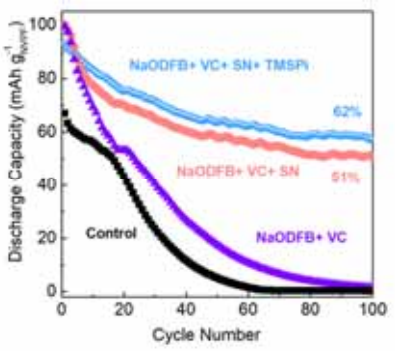
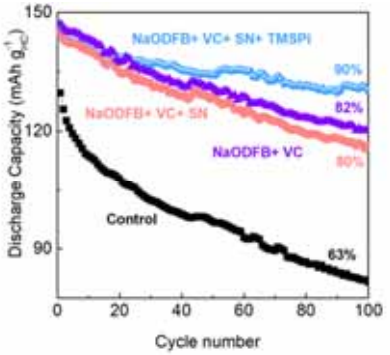
Deterioration due to NVPF



Deterioration due to HC



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- NaODFB and VC stabilize the negative electrode
- SN is must to stabilize the positive electrode
- TMSPi addition improves performance in both sides

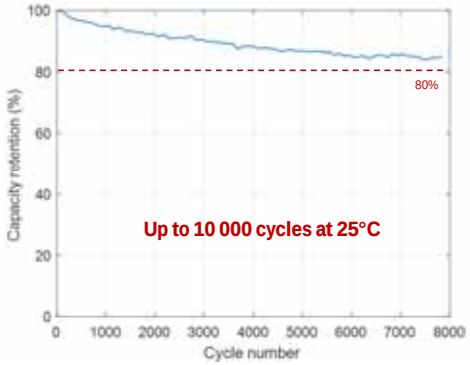
Deciphering Interfacial Reactions via Optical Sensing to Tune the Interphase Chemistry for Optimized Na-Ion Electrolyte Formulation P. Desai, J. Huang, H. Hijazi, L. Zhang, S. Mariyappan, J.-M. Tarascon Adv. Energy Mater. 2021, 11, 2101490

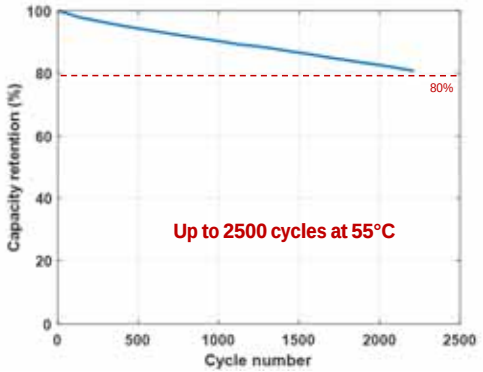
Gen[1] NVPF / HC solution

Cycling test 2C/5D full DOD

Long **lifetime**

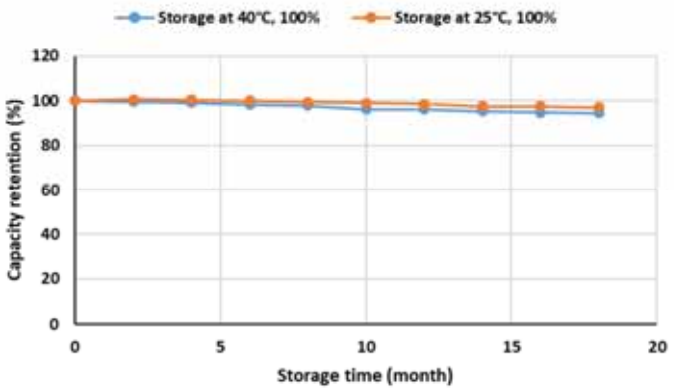
Superior cycling ability
even at high temperature





Lifetime performances
Calendar Ageing

The cells are stored at **different temperatures**
The characterization is applied at C/2 charge discharge.



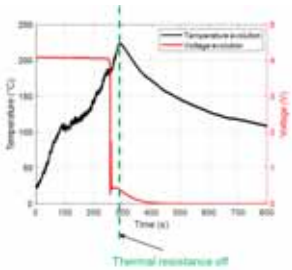
Gen[1] solution

Overheating test at 100%SOC

Extreme **Safety**

Weight loss 28%
Vent open, electrolyte leakage

NO FIRE

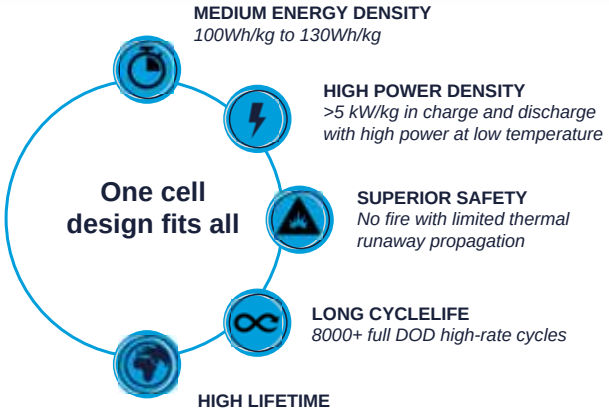


Before

During

After

Summary :
NVPF-HC : a technology for High Power Market



High Power Battery Market

Competition : **LTO – NMC power**

Advantages over competition :
Product availability (Lithium for high energy density)
Cost (vs LTO)
Extreme safety
Cycle life (vs NMC power)

Power tool application

TIAMAT

A world premiere :
first commercialization ever of sodium-ion cells in a product

An eco-responsible European battery allows for rapid charging

Temperature increase in use must be limited
User safety is important

The same format and operating voltage as lithium-ion made it easier to integrate the solution

Multiyear commercial contract after successful marketing test

300 kUnit/y

ades LEROY MERLIN

From lab to contract manufacturing before own production

TIAMAT

LRCS

ZENERGY

Up to 100 MWh/y (800 kUnits)

鹏辉 GREAT POWER

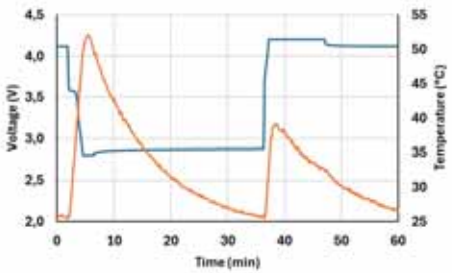
Up to 1 MWh/y (300 kUnits)

NVPF-HC prismatic cell performances

TIAMAT

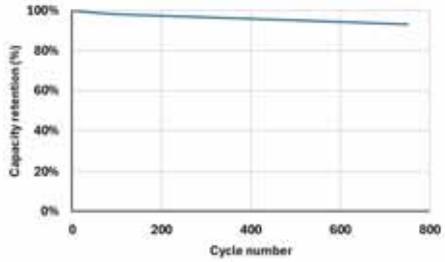
20C charge – discharge profile at 25°C

Cell voltage and temperature evolution:



20C charge – discharge profile at 25°C

Cycling : Charge 20C-CV to 1C, discharge 20C-CV to 1C

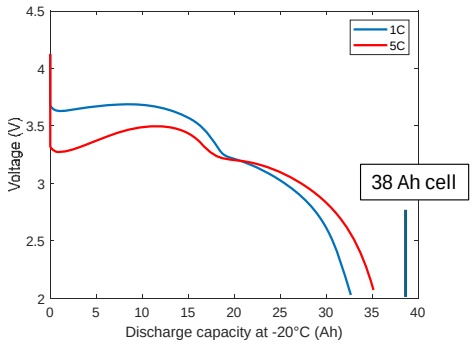


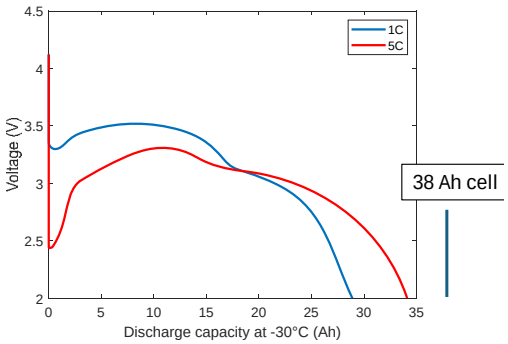
Capacity retention of 93% after 750 cycles

=> Good cycle life stability

NVPF-HC prismatic cell performances

Low temperature performances





NVPF-HC prismatic cell performances

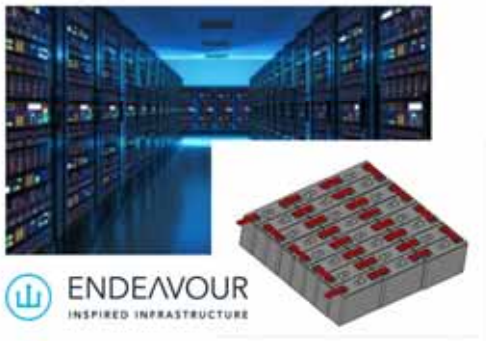
	Target Roadmap 2021	Results 2025
Energy density (Wh/kg)	105	110
10s pulse discharge resistance @70% SOC @ 25°C (mOhm)	0,5	0,3
10s pulse discharge resistance @70% SOC -20°C (mOhm)	9	0,5
Max increase resistance EoL	120%	120%
Monthly self-discharge @50% SOC - RT (%)	<2%	1%
2C 5D Cycling - 0 to 100% DOD - RT (cycles number) at 80% Capacity	5000	12000
Calendar ageing @75% SOC - RT (capacity loss after 60 days %)	5%	<1%

Objective overpassed

UPS application

- High-power system using less capacity to assure a peak power management
- Important lifetime allows to TCO gain
- Low risk of thermal runaway
- Module development for series production and first prototype rack

Major offtake contract :
Full capacity of planned factory's block1 (hundreds of MWh)

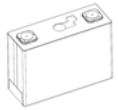


Hybridization application

- A lightweight, high-power battery for hybridization of the thermal engine
- Best performance for cold cranking at -10°C
- Low risk of thermal runaway facilitates system integration
- B-sample under testing by a car manufacturer

Tiamat UPS module/rack for Datacenters

Cell (52148 prismatic)



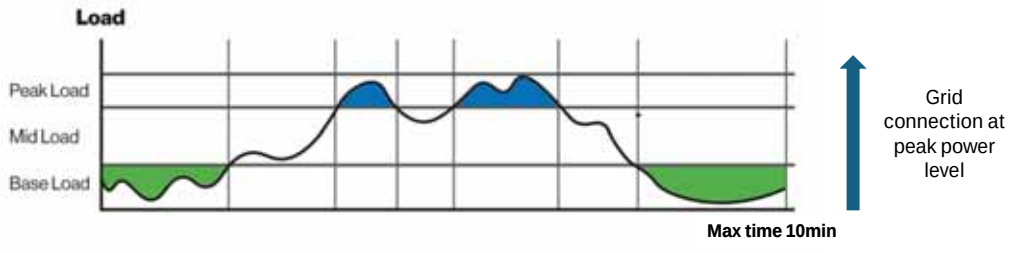
Module (5kWh – 133V – 100kW)

Power Distributor Unit

Specifications of cell

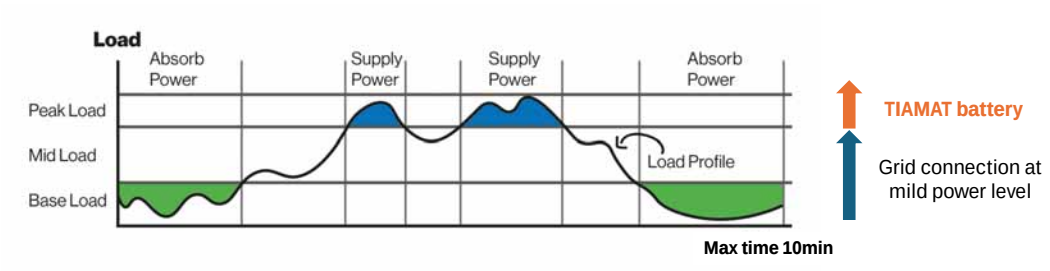
Capacity (Ah)	38
Charge time (min)	<5
Discharge Continuous Crate	20

Datacenter: Energy consumption



High connection cost and limited availability power

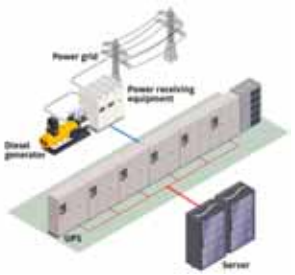
Datacenter with TIAMAT battery



High power battery to supply peak power with less grid power

Datacenter with TIAMAT battery

Conventional configuration



Configuration using TIAMAT battery

Less footprint with extreme safety

Industrial roadmap

And then...

1st sodium-ion gigafactory in Europe

SOP Q2 2026 with immediate capacity of **0.6 GWh/year** and extension plans to **5 GWh/year**

Contract manufacturers will accompany Tiamat from design to SOP

High Energy Battery Market

Gen²

Competition : **LFP**

Advantages over competition :
- Agnostic to Li price and availability fluctuation
- Sovereign supply
- Low and predictable cost
- Fast charge ability

740 GWh in 2030*
210 GWh in 2030
>20 GWh after 2030

THANK YOU FOR YOUR ATTENTION

TIAMAT

STELLANTIS Ventures
ARKEMA
SYNENSQO
ENDEAVOUR
mobility
ALSTOM · mobility by nature ·
adeo

TIAMAT

LA FRENCH TECH 2030

Sodium-ion family

- Layered oxides
  - Gen²
  - faradion
- Polyanionic materials
  - Gen¹
- Prussian blue analogs (PBAs)

CATL

O3-type

P2-type

$Na_3V_2(PO_4)_2F_3$

Na-ion Battery

Carbonaceous

Hard Carbon

Metal Oxide

Metal Alloy

Additive

Binder

Solvent

Na Salt

CATL

ALTRIS

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