Micro Solid State Batteries Enabling Medical Devices and IOT

Denis Pasero – Product Commercialisation Manager

PWR SOC 21

ilika

Ilika Solid State Batteries

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Stereax
Miniature battery technology for
MedTech and Industrial IoT

Goliath
Large format battery technology for
Electric Vehicles, Consumer Electronics,
Aerospace, Military

Requirements for Edge Nodes Connectivity

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Perpetual Autonomous solutions needed

Small-size unobtrusive, for hard-to-reach places

Low cost of ownership (no battery change)

High and low temperature environments

Safe, reliable technology

Perpetual Beacons

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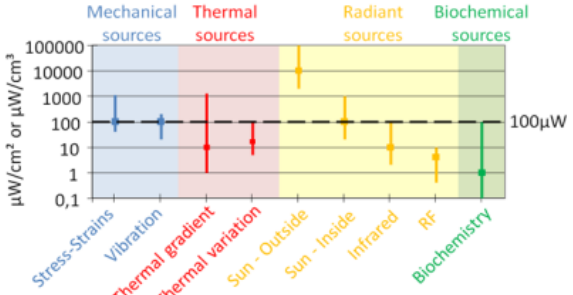
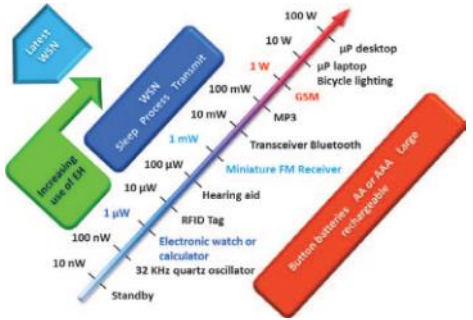
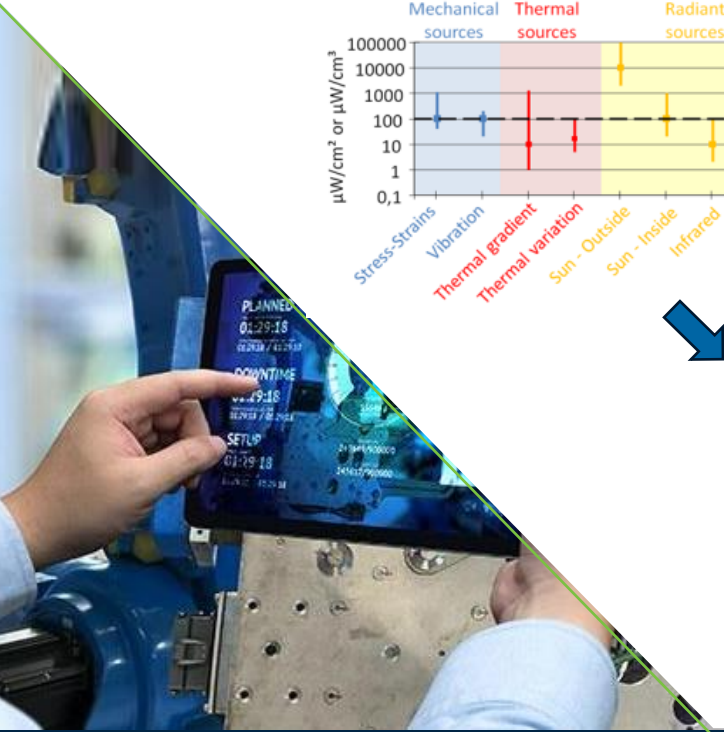
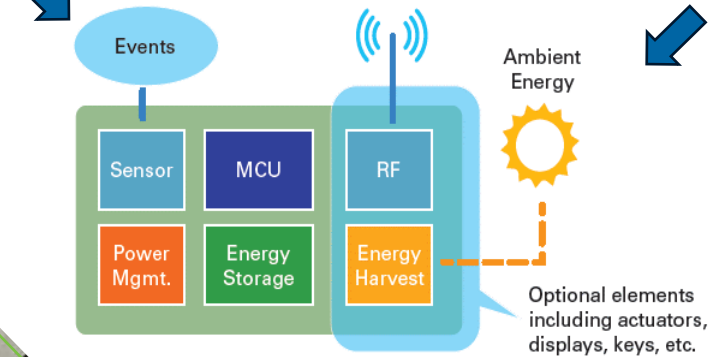
Efficient energy harvesters



Ultra low power electronics, sensors, communication and PMIC







Thin Film Solid State Batteries

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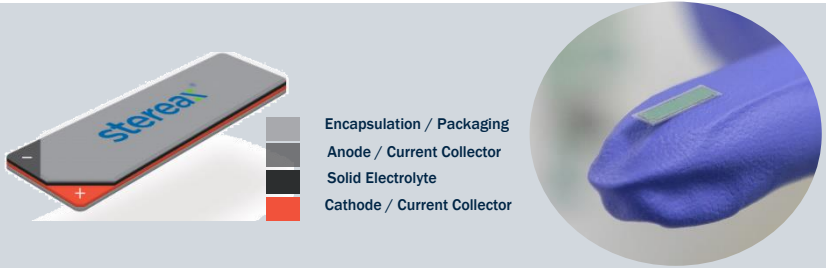
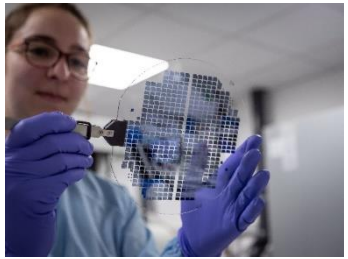
Rechargeable SOLID STATE Li-ion Chemistry

No liquid or polymer electrolyte
Won't leak or explode!



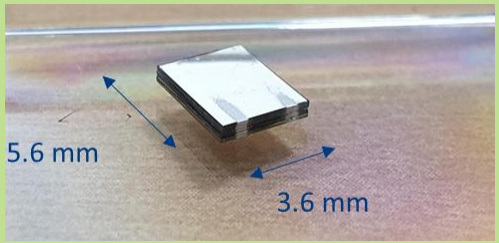
Fabricated using equipment from semi-conductor and MEMS industry

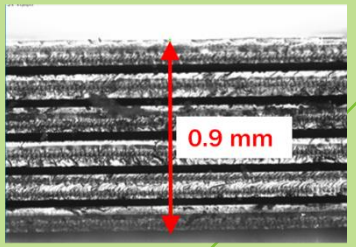
Deposited by single-step co-evaporation;
Patterned by photolithography and etching



Advantages

- Safe
- Ultra-small and thin
- Stackable cells (increase energy density)
- Predictable cycle life (1000s cycle)
- High power capability
- Operating temperature to 150 °C





Design Considerations

Energy and Power Capabilities

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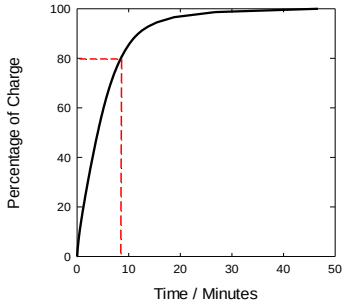
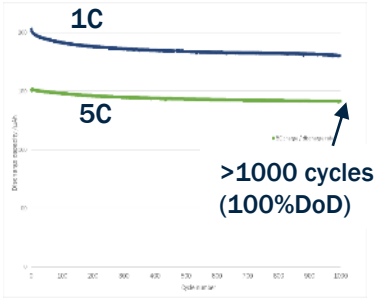
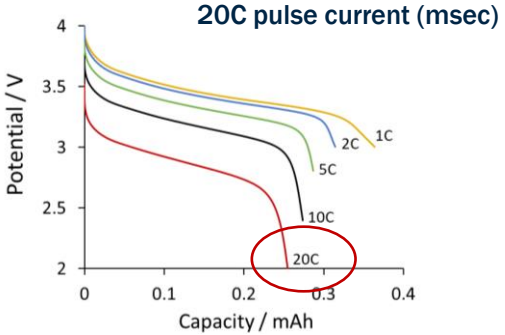


Rapid charging (80% in 8 min)



High cycle life at high rate (>5000 at partial DoD)

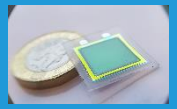


High discharge rates (e.g. can power BLE)

Energy density road map

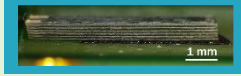
NOW

"M250", 250 μ Ah
30 Wh/L



In development (Q1 2022)

"M300"
300 μ Ah
60 Wh/L



On our road map (2023)

"M1000", 1000 μ Ah
200 Wh/L

Design Considerations

Size, Shape and Handling

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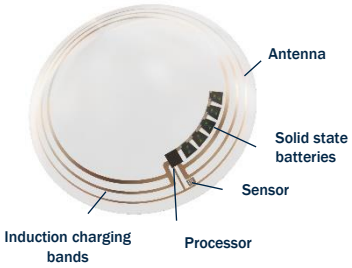
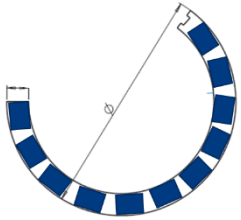
SSB shapes are customisable

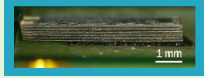




Dimensions road map

NOW
xy: 18 x 20 mm
z = 0.7 mm

In development (Q1 2022)
xy: 5.6 x 3.6 mm
z = 0.15 mm (cell)
Z = 0.9 mm (6-cell)



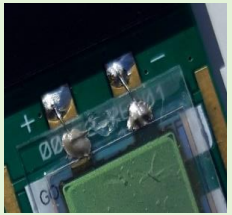
On our road map (2023)
xy: 2.5 x 2.5 mm
z = 0.1 mm (cell)

smaller

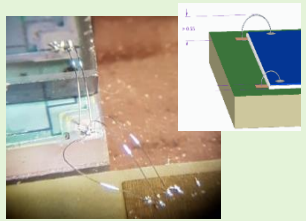
Connections

- No need for battery holder
- SSB are not solderable

Conductive epoxy
(Ag / Carbon; room temperature)



Wire-bonding
(room temperature; Ag/Pt)



Design Considerations

Power management

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- Increasing number of off-the-shelf ultra low power PMIC
  - Texas Instruments bq25570
  - Analog Devices ADP5091
  - E-peas AEM10941

Description
Battery protection (operational voltage window)
Output voltage conversion: 3-4V → useful voltage
Regulate input current and voltage (Energy Harvester)
Mm-scale footprint
Low quiescent currents

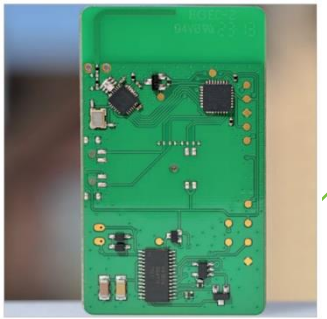
100 µAh SSB
@ 3.5V

↓

+40%
@ 1.8V

- Some OEM prefer to design their own ASIC including such functions
  - MICRODUL MA198

Description
Detect voltage levels for organising power flow or charging
Switch power from different sources, switch output power on or off
Use ultra-low-power
Buck and boost voltage
Battery charge management



Design Considerations

Electric leakage and shelf life

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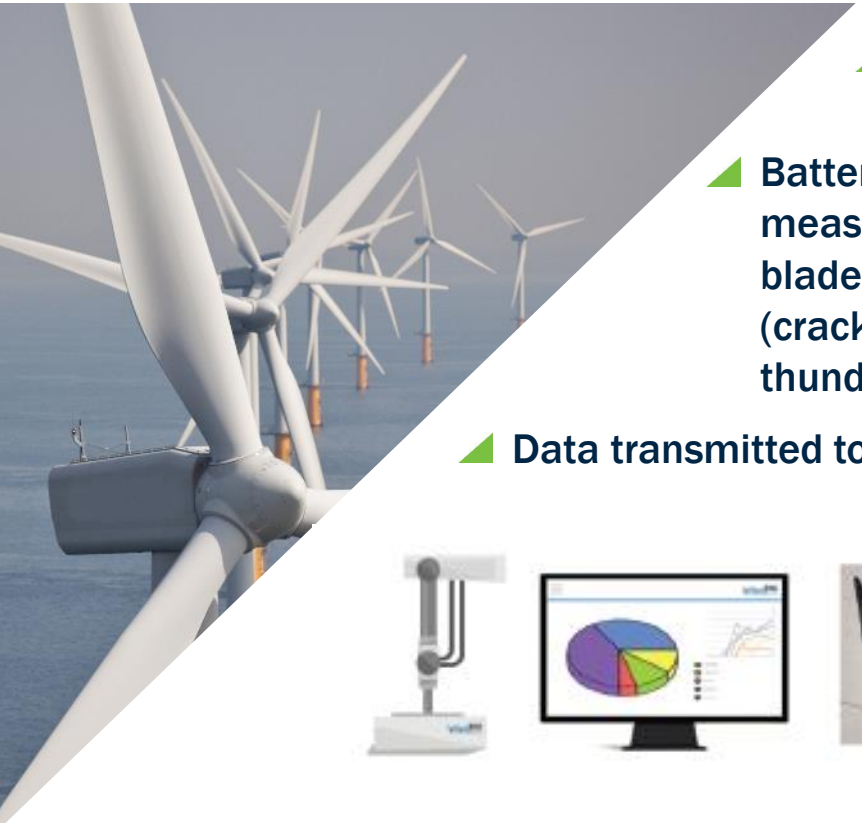
- Energy storage components self-discharge via leakage current – Only partially recoverable
- During unused periods; Non-Zero loads and switches; Shorts
- Quiescent current contributions:
  - *Communications*
  - *Sensors*
  - *MCU sleep mode*
  - *PMIC*
- Medical cylindrical batteries have Zero-volt technology

Battery system	Estimated self-discharge	Ref 1
Primary lithium-metal	10% in 5 years	
Alkaline	2–3% per year (7-10 years shelf life)	
Lead-acid	5% per month	
Nickel-based	10–15% in 24h, then 10-15% per month	
Lithium-ion	5% in 24h, then 1–2% per month (plus 3% for safety circuit)	

Energy source	Leakage current level	Yearly loss
Solid state batteries	1nA	10μAh
Pulse caps	10nA	100μAh
PMIC	100nA	1mAh
Supercaps, coin cells	1μA	10mAh

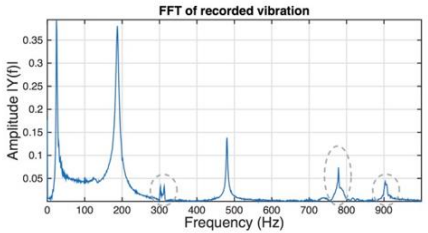
Applications

Remote Condition Monitoring



- Harvested energy: solar + vibration
- Battery powers transducer which measures vibration spectrum of blade as a “signature” of its health (cracks, delamination, rain, thunder…)
- Data transmitted to Cloud via Gateway (BLE)

© WindTak



Applications

Embedded Electronics

AMANDA

- Memory Back-up
- Real Time Clocks
- MCU Back-up
- Smart Electronic Cards
- Asset Tagging
- Electronic Shelf Display
- Embedded Security

Stereax benefits

- Ultra low leakage current
- High energy density
- Small and thin
- Large cycle number

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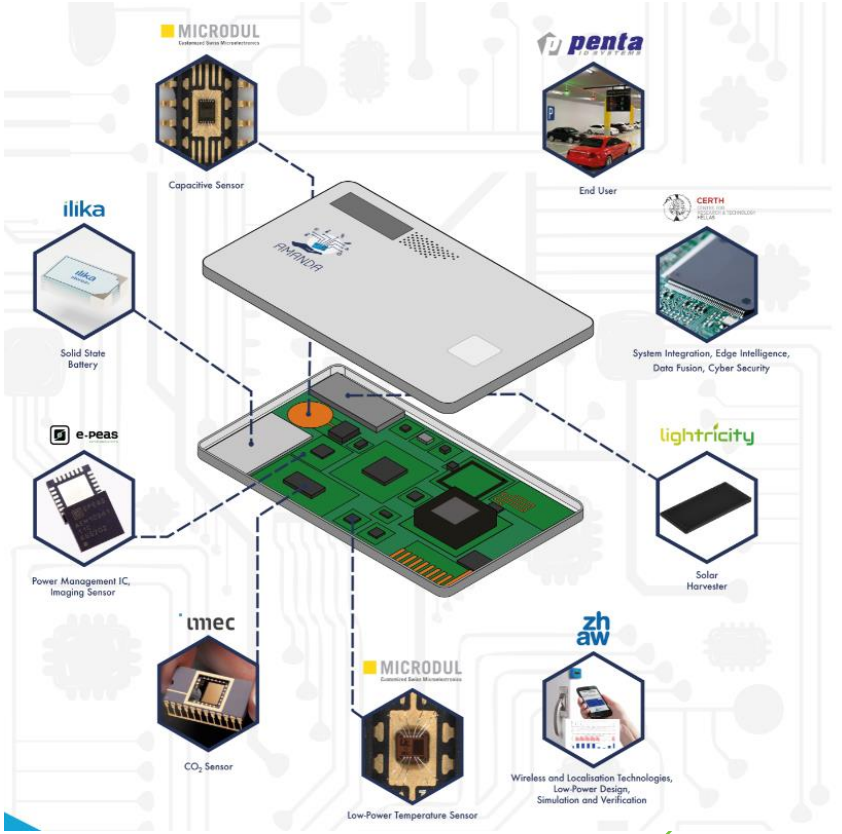

Applications

Smart e-ink display

PLASTIC LOGIC

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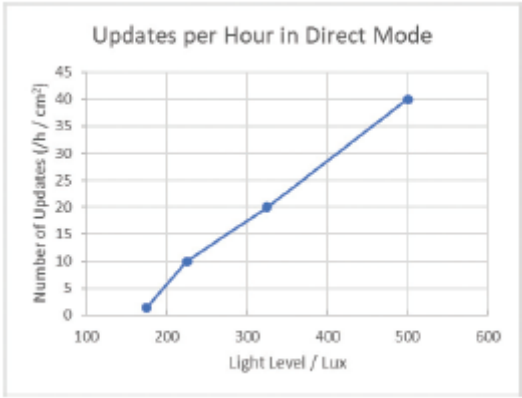
- Plastic Logic's flexible, segmented, glass-free EPD technology
- Smart version uses Solar harvesting

Flexible
Glass-free display
24/7 Operation
Extra thin

Component	Model
Display	Plastic Logic – Segmented EPD
Solid State Battery	Ilika Stereax M250, 250 uAh, 3.5V
Super-Capacitor	Cap-XX HS230
Solar Panel	Lightricity EXL1 module

- 15 updates / hour at 300 lux
- 60 update in the dark



Applications

Next Generation Active Medical Implanted Devices

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Enabled

CURRENT GENERATION

- Large size 10-20 cm^3
- Primary or secondary
- > 50-100 mAh

DISRUPTIVE PRODUCT DESIGN

- Small size < 1 cm^3
- Miniaturised components
- Energy harvested from the body
- Ultra-low power electronics

NEW CONVERSATION WITH PATIENTS

- No need for invasive and risky procedure
- Charging can be done at home
- BUT more regular recharges (daily/weekly)

NEXT GENERATION: Best fit for SSB!

- Ultra-small and thin
- 1000s cycles
- Unusual shapes
- SAFE

Path to Manufacturing

- Floor: 1,600 m²
- Clean rooms: 340 m²

2020

- $20m Investment
- Equipment purchase and FAT

2021

- Q2: Equipment SAT
- Q3: Facility Fit-out
- Q4: dFMEA design

2022

- Early production of prototype M300 and M600
- Production ramp up: 1000wfr/y
- Start of reliability program

2023

- Early production of prototype M1000
- Production ramp up: 2000wfr/y
- Full solution reliability program

2024

- Early production of prototype D
- Production 4000wf/yr
- Dataset ready for FDA audit

Next Prototypes: Stereax M300

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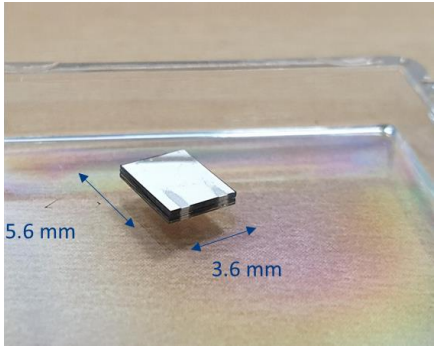
Parameter		Stereax M300, 6-Stack 3.6 mm x 5.6 mm
Thickness	/ µm	≤ 900
Rated capacity	/ µAh	300
Energy density	/ Wh/L	60
Nominal voltage	/ V	3 – 4
Internal resistance	at 25 °C / Ω	200
Standard discharge current	/ µA	300 (1C)
Peak current	/ mA (0.5 ms, 3 pulses every second)	3 (10C)
Maximum continuous current	/ mA	1.5 (5C)
Cycle Life at 37 °C	(100% DoD to 80% capacity) / cycles	> 400
	(50% DoD to 80% capacity) / cycles	> 800



M300

- In-house devices Q1 2022 , Post HALT testing (for issue outside Ilika) Q2 2022

Call to action

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EVALUATION

Evaluate Stereax standard products

CUSTOMISATION

Ilika can design a battery to fit your requirements

PROTOTYPING

Ilika can provide low volumes of batteries for prototyping, internal testing, field trials

MANUFACTURING

Ilika is transferring its solid state battery technology to foundries

Or you can take a license to have the batteries manufactured

Keep in touch!

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Thanks a lot for your time and attention!

Any questions and/or comments?

- www.ilika.com
- Contact: info@ilika.com

- @ilikaplc
- /ilika-plc

Unit 10a The Quadrangle, Abbey Park Industrial Estate, Romsey SO51 9DL

Tel: +44 (0)23 8011 1400

www.ilika.com