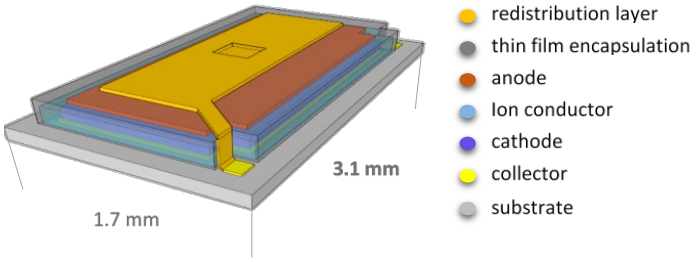
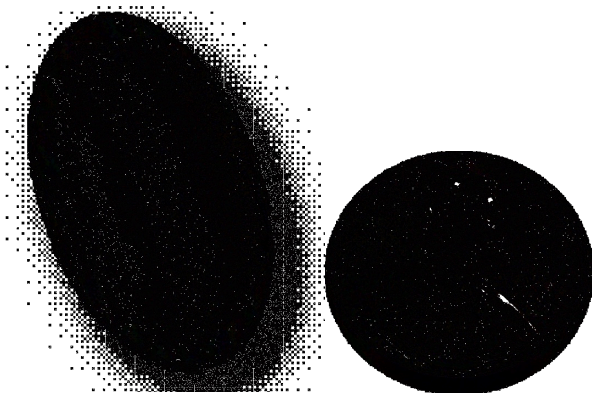
Rechargeable solid-state lithium ultra-thin film battery for implantable medical devices

Features

- All solid-state
- Ultra thin and ultra compact
- Fast recharge
- Long cycle life
- RoHS compliant





Applications

- Medical devices : implantable or wearables components
- Energy storage for energy harvesting devices
- Back-up power

Description

The micro battery is a thin film rechargeable solid-state Lithium battery. The battery has a $LiCoO_2$ cathode, LiPON ceramic electrolyte and a lithium anode.
This device has a footprint of 3.1 x 1.7 mm²

Manufacturing process is based on 200 mm wafers, using state of the art of CMOS-like equipments

Table 1. Device Summary

FEATURE	VALUE
Capacity	20 µA.h
$V_{Nominal}$	3.9 V
$V_{Operations}$	3.6 to 4.2 V
R_{Int}	7 KΩ
I_P	NA
Dimensions	3.1 x 1.7 mm²
Thickness	100 µm

Characteristics

Table 2. Absolute Ratings

Symbol	Parameter	Value	Unit
V_{Op}	Operating voltage	3.6 - 4.2	V
I_C	Maximum continuous discharge current	0.1 0.25	mA mA (@ 37°C)
I_P	Maximum pulsed discharge current (1)	NA	mA
T_{Stg}	Storage temperature range	-40 to 60	°C
T_{Op}	Operating temperature range(2)	-40 to 60	°C
C_{Life}	Cycle life (to minimum of 80% of initial capacity) (3)	NA	Cycles

(1) Pulsing conditions: 100 ms on, 0.9 s off
(2) 1/100 C discharge at -40 °C: operating at 60 °C reduces the cycle life
(3) 1C discharge rate: 50% depth of discharge, cycle at room temperature

Table 3. Electrical Characteristics

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
C	Nominal Capacity (minimum)	T = 30 °C Discharge @ 1 mA Cut-off voltage = 3.6 V	19	20	25	µA.h
R_{Int}	Internal Resistance	T = 37 °C	6.5	7	8	KΩ
C_t	Charge time to 80% of full capacity	Constant voltage= 4.2 V	110	120	140	mn
S_{Disch}	Self-Discharge : estimated data based on leakage current	Total self-discharge (recoverable and non-recoverable)			3	% / year
		non-recoverable			3	% first year
					15	% over 5 years

Fig 1. Typical Discharge Curve (at 37°C)

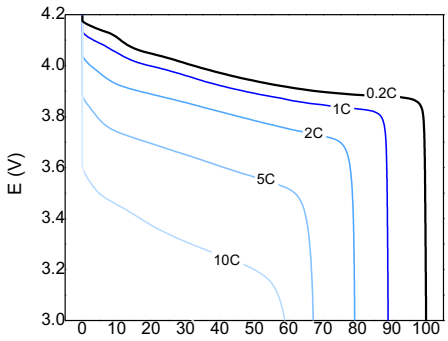


Fig 2. Typical Charge Curve - at 25°C (blue) and 37°C (red)

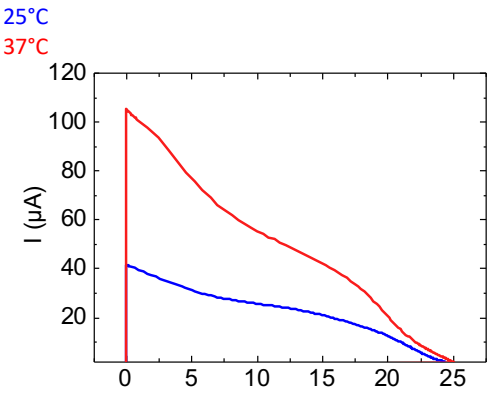
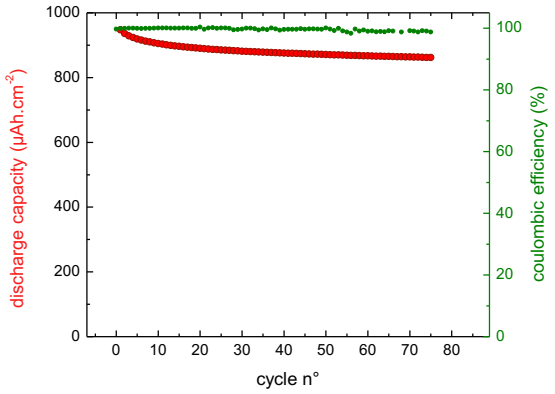
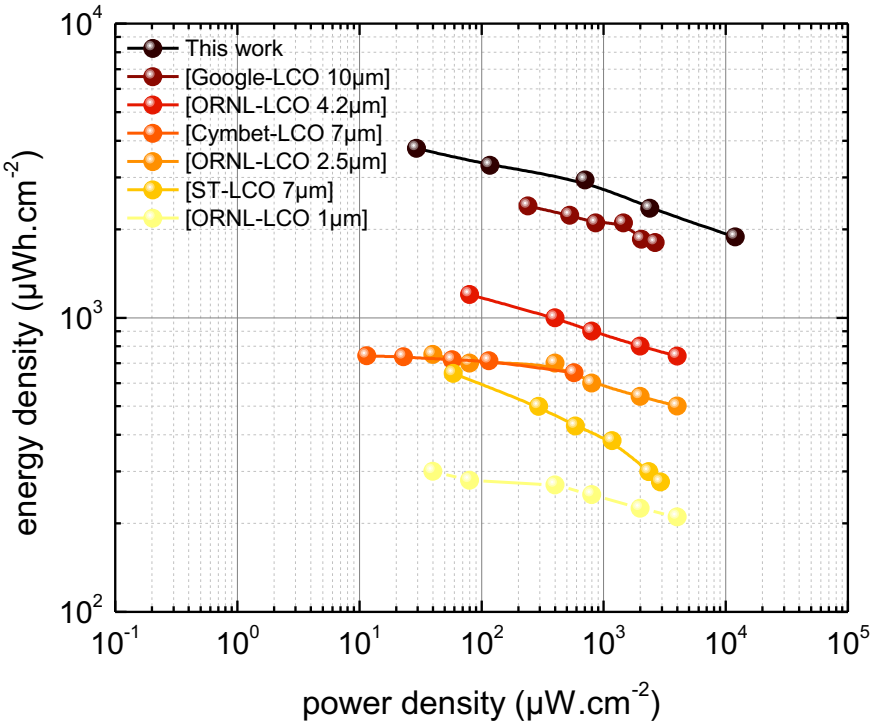


Fig 3. Typical capacity variation with cycling at 37°C (1µA, 3-4.2V)



Application information

Fig 4. Comparison with other existing and established technology/solution



To be completed with some other solutions such as Ilika, Front Edge Technology + addition of other graphics with some projections based on stacking option

Smallest micro batteries (< 0.15 mm^3) have been designed and tested with following performances:

Size	Thickness	Capacity	Energy
2 mm x 0.7 mm	0.1 mm	5 µA.h	19 µWh

Several additional features are available upon request. Stacking of batteries is possible to increase capacity.

Table 4. Typical ranging demonstrated for 0.1 mm battery thickness

Surface	Capacity
1,4 mm² to 1 cm²	3 - 300 µA.h

Recommended charge and discharge processes

Charge

Battery can be charged from a 4.2 V ± 0.05 V constant voltage source with or without current limit. More than 90% of the total capacity is recharged when the charge current falls below 0.2 µA.

Discharge

When discharging under constant current or constant load, the cut-off voltage should be no less than 3.6 V. Cut-off voltage can be lowered to 2.0 V for pulsed discharge.