

Future Batteries Applications and Related Technology Trends

renata

renata
batteries

No ticking
without a
RENATA
battery ...



Europe, Switzerland



Campus in Itingen



Itingen near Basel

>800'000
Batteries per day

**Coin Cell Assembly and
Quality Control**

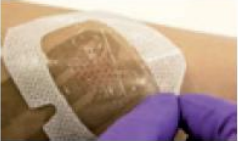


Future Batteries Driven by Application Requirements

Glucose Metering Battery Customers 2005



Simple portable measurement device with primary lithium cell

	Historically	Increasingly	Eventually
Glucose monitoring	Self monitoring of blood glucose using electrochemical test strips and glucometers 	Continuous glucose monitoring using wearable devices 	Towards smaller, less invasive (non-invasive?), monitoring options 
Insulin delivery	Injection using insulin pens or directly 	Insulin pumps, with increasing levels of automation, starting with dose recommendation 	Closed loop, automated insulin delivery ("artificial pancreas") 
Side effect management	Ketone monitoring via test strips Traditional diabetic footwear Other medication 	Smart footwear for prevention, management and monitoring of foot ulcers 	Many advanced solutions have been proposed, from smart skin patches to wound care options 

Quoted from IDTechEx

Technology Change Continious

Wearable

Company	 Medtronic	 Dexcom	 Abbott
Device name	MiniMed / Enlite™	G-series	FreeStyle Libre
First CGM device approved	1999	2006	2008
Calibration	12h	12h (G6 factory)	Factory
Testing frequency	5 mins	5 mins	15 mins
Sensor lifetime	5 days	7 days	14 days
Communication method	Bluetooth	Bluetooth	NFC**
Diabetes revenue (2017) /USD millions	1,927	719	1,414
Approx. CGM revenue (2017)* /USD millions	~720*	719 (all CGM)	~ 400*

Implantable

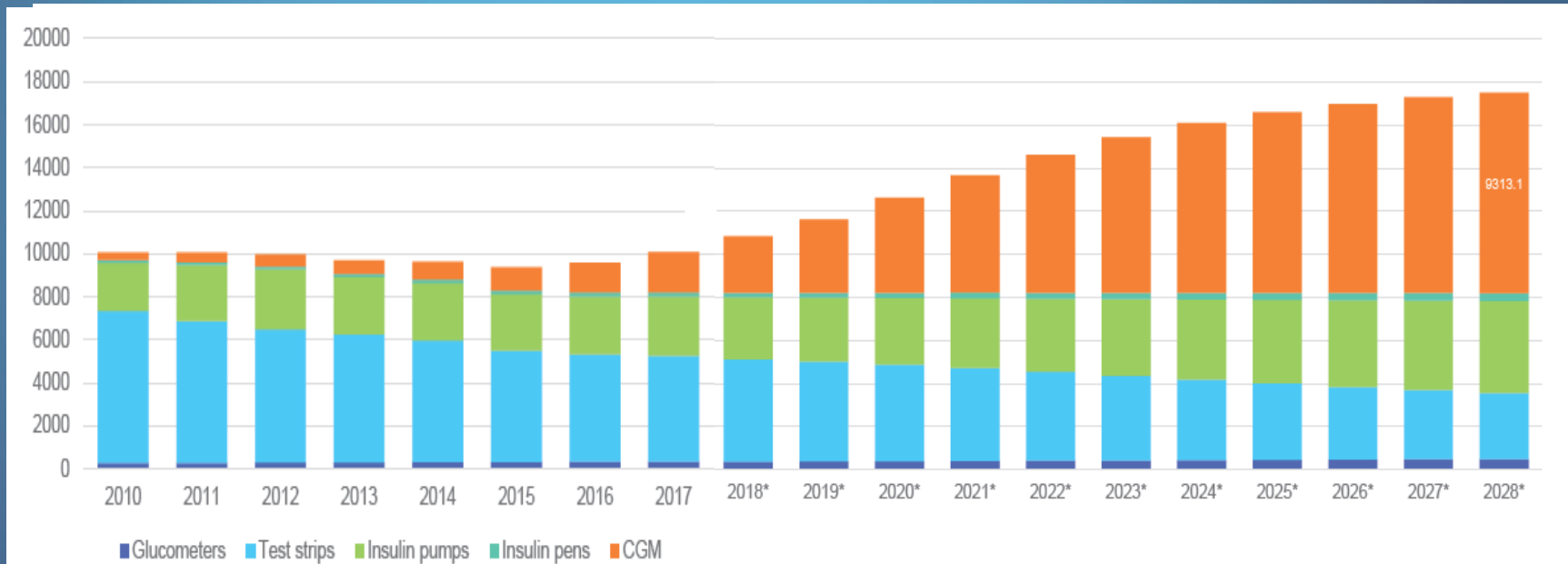
 Senseonics  Roche
Eversense
2017
12h
5 mins
3 months
NFC (sensor to transmitter) Bluetooth (transmitter to phone)
See below
<< others (estimate ~\$10m)

Pre-approval

Wearable	 PK Vitality	 PANCREUM
Implantable	 profusa	 GLYSENSE Implantable Glucose Sensor
	 GlySens Live now. Ready for the future.	

Source: IDTechEx

Technology changes the Market



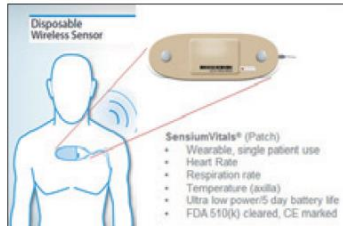
Quoted from IDTechEx

Skin patches for inpatient monitoring

- If inpatient monitoring can be achieved using portable devices, it allows patients to be more mobile during their hospital stay, resulting in fewer complications resulting from immobility.
- Various companies are developing and commercialising ambulatory monitors for use by patients in a hospital setting.
- IDTechEx estimates the total revenue ambulatory inpatient monitors will be approximated \$75-80m in 2018*.

SENSIUM
part of The Surgical Company

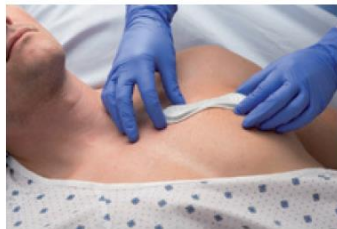
Senses: HR, RR, skin temp.
Approvals: FDA & CE mark



SensiumVitals patch
Source: Sensium

VitalConnect

Senses: HR, RR, skin temp, motion
Approvals: FDA & CE mark



Vital patch
Source: Vitalconnect

isansys

Senses: HR (ECG)
Approvals: CE mark



Isansys Lifecare's Lifetouch product.
Source: Isansys Lifecare

Leaf Healthcare

Senses: Motion & position
Approvals: FDA



The Leaf sensor is attached to the patient's upper chest (via adhesive).
Source: Leaf Healthcare

Influence on Temperature Sensing

QUALCOMM LIFE
a Qualcomm company



Early prototype of Qualcomm Life's biometric sensing patch.
Source: Jamie Hartford/MD+DI

LifeSignals



Life Signal™ patch demonstrator.
Source: LifeSignals

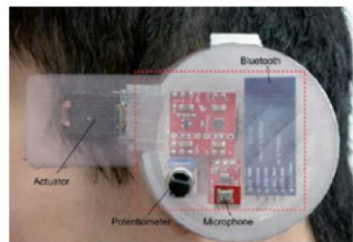
mc10



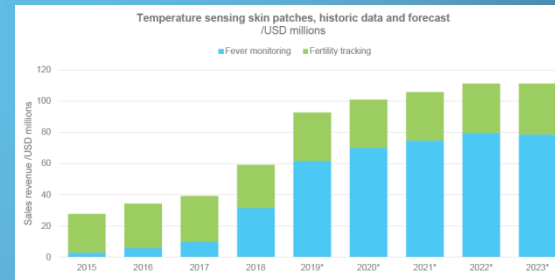
MC10's BioStamp product
Source: MC10



New types of wearable system have been demonstrated

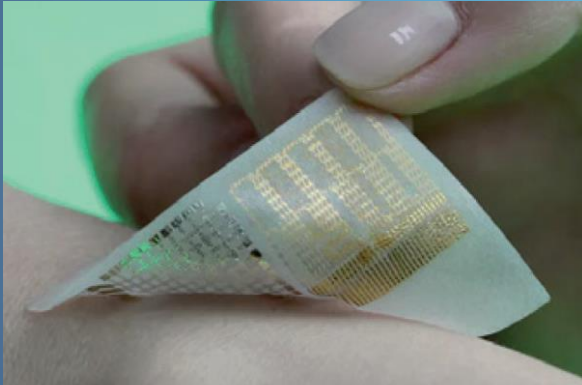


UC Berkeley researchers showed an ear-worn 3D printed IR temperature sensor to measure body temperature.
Source: UC Berkeley



Source: IDTechEx

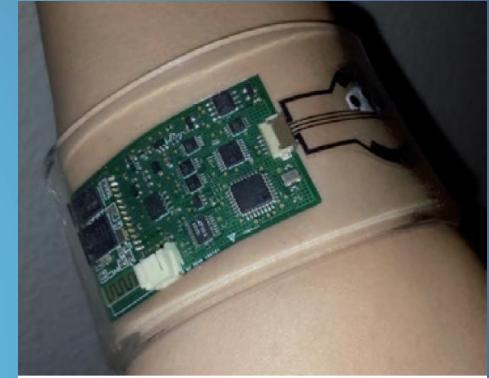
Opportunity for other Skin Patches



Electronic skin patch for Parkinson's treatment
Image Source: Seoul National University



Source: "Nicotine Replacement Therapy: from
verywellmind.com

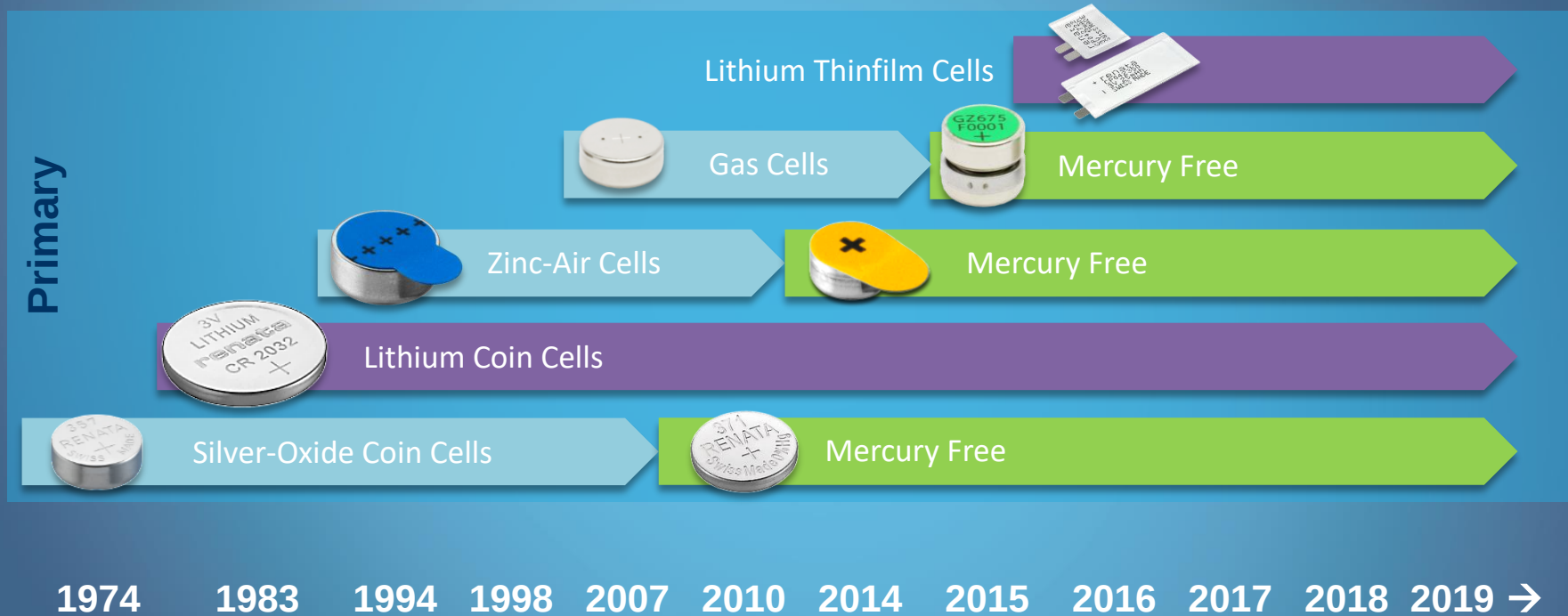


*A wearable sensor that extracts sweat and analyzes its
constituents could be a useful device for diagnosing and
monitoring diseases, like CF and diabetes.*
Source: Sam Emaminejad/Stanford School of Medicine

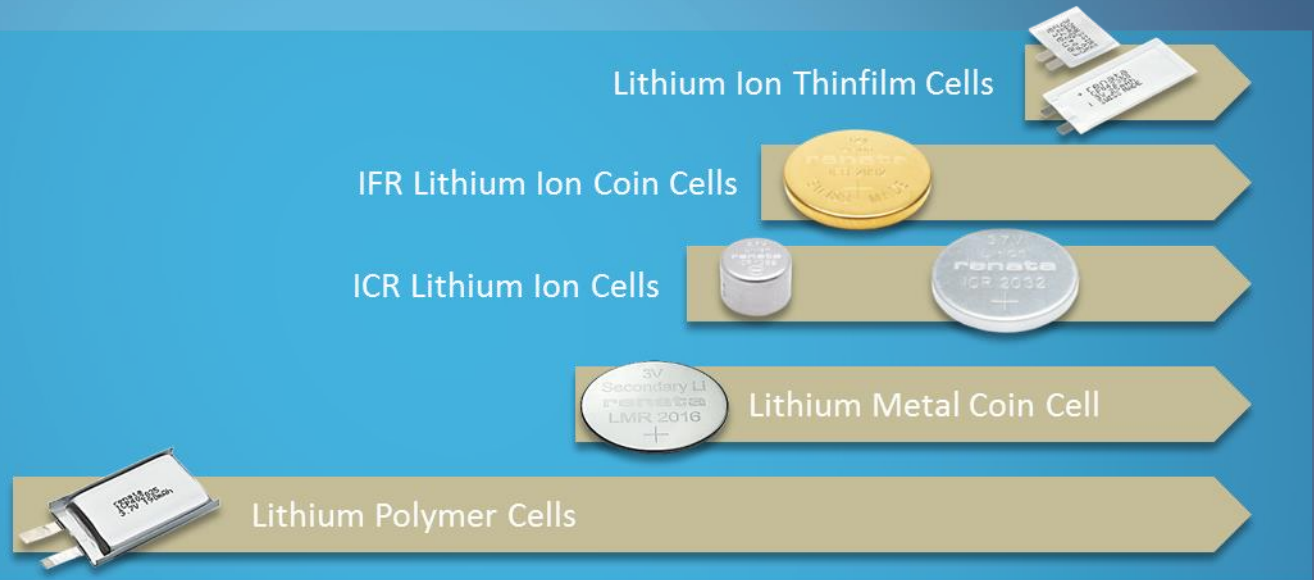
Drug and cosmetics delivery skin patches

RENATA NEW TECHNOLOGIES for the new opportunities

Roadmap

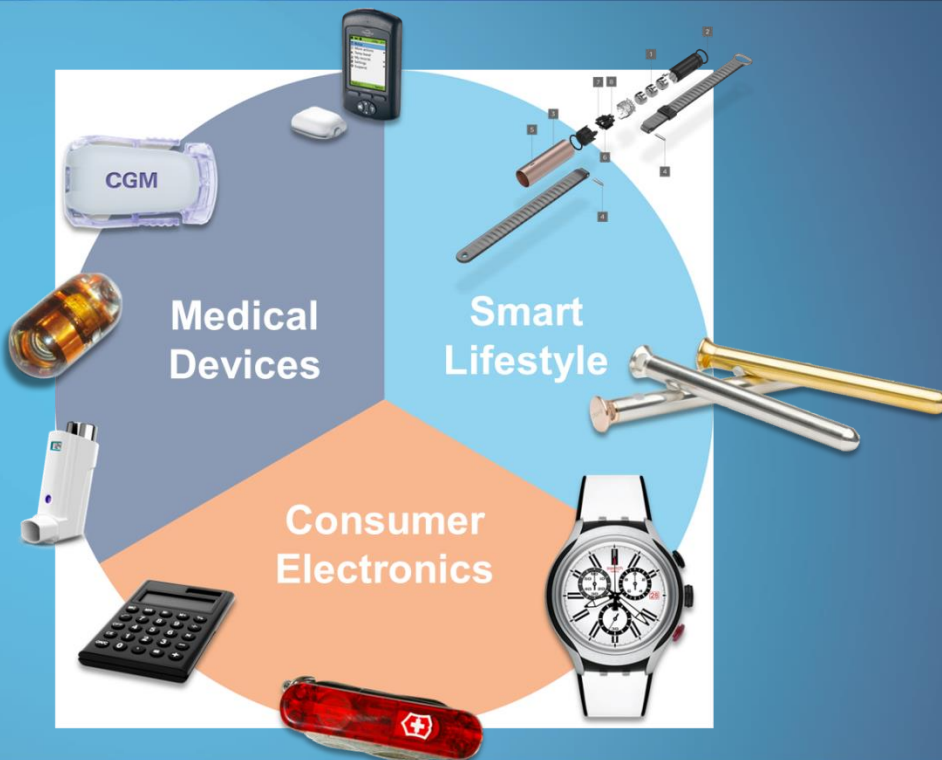


Secondary



1974 1983 1994 1998 2007 2010 2014 2015 2016 2017 2018 2019 →

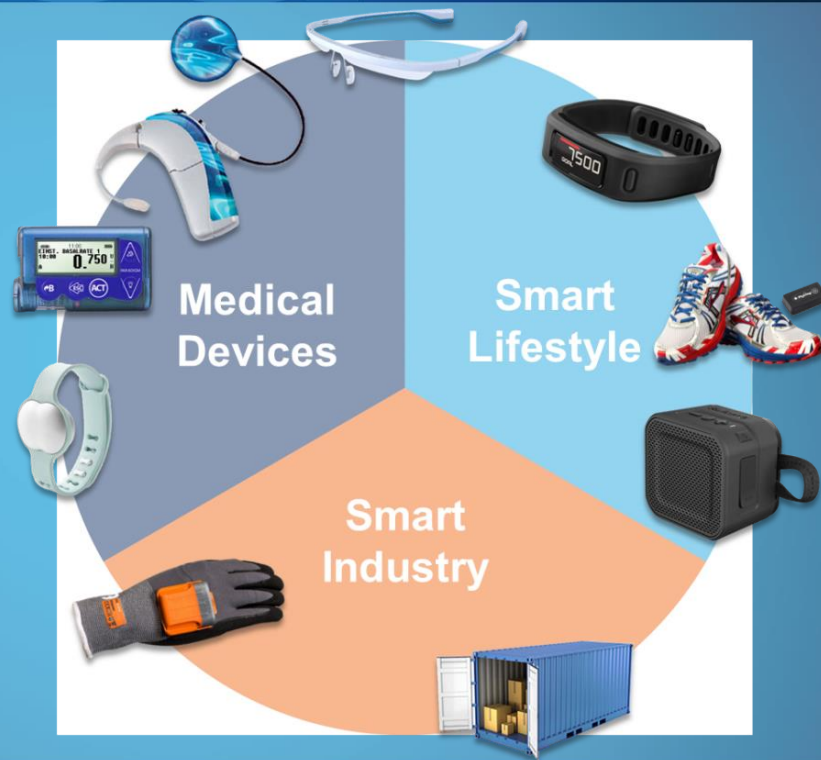
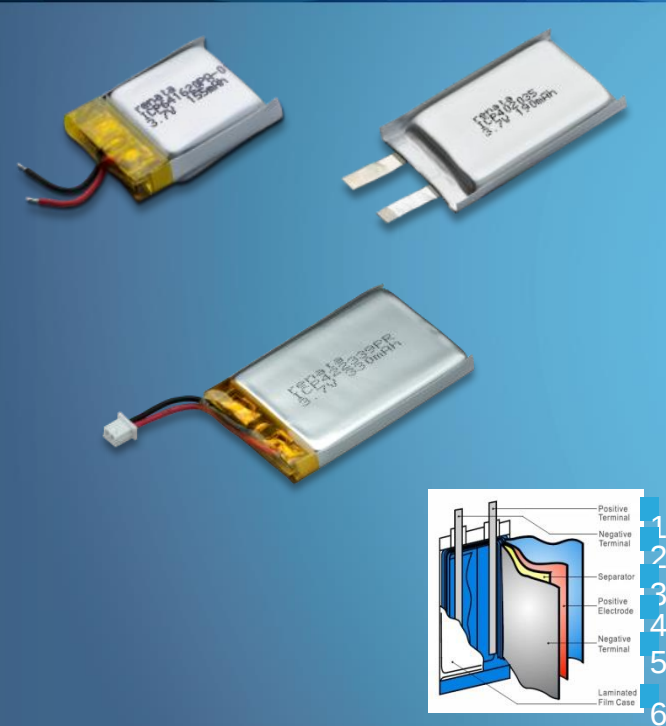
Silver Oxide – from Watch to...



Lithium Primary from Memory Backup to...



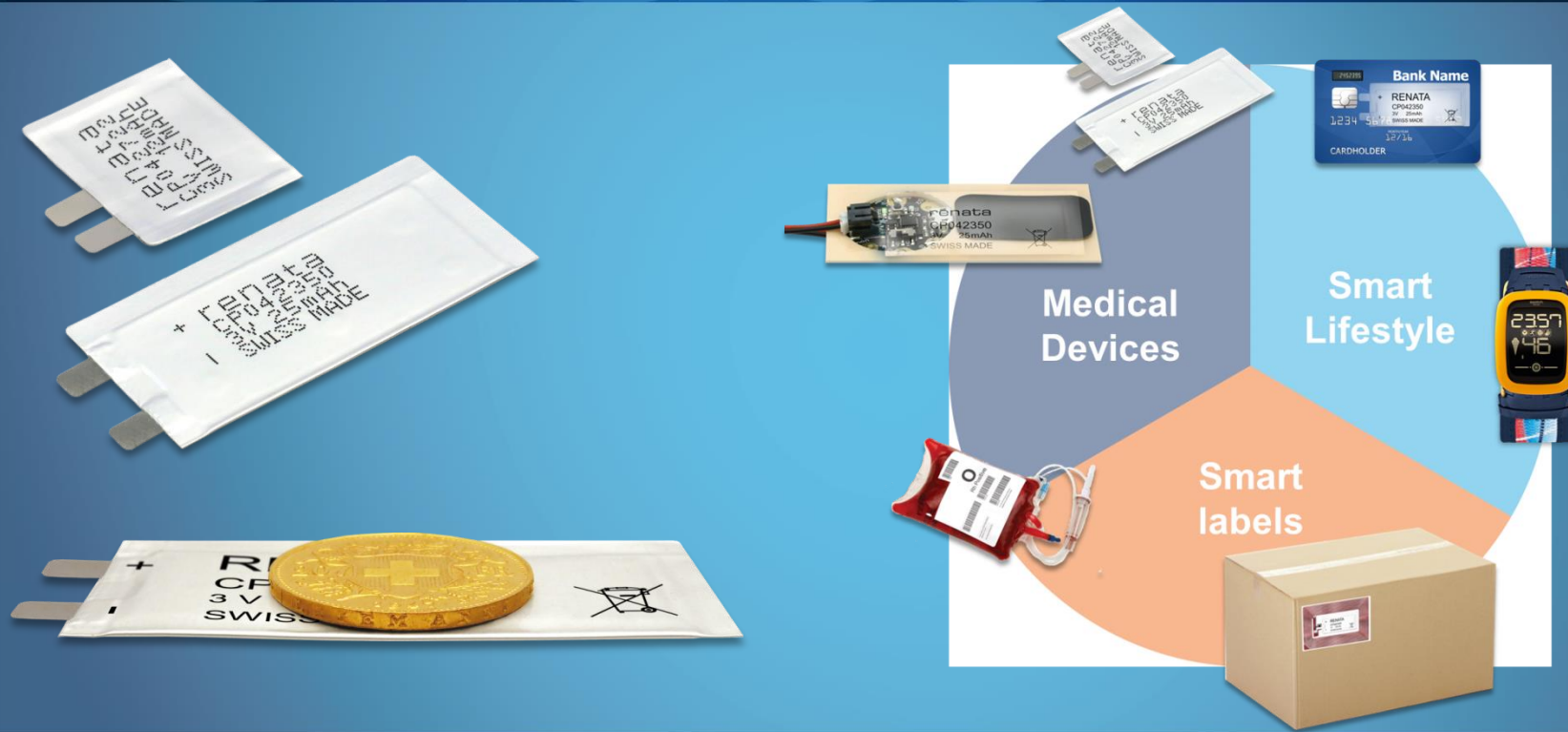
Lithium Polymer



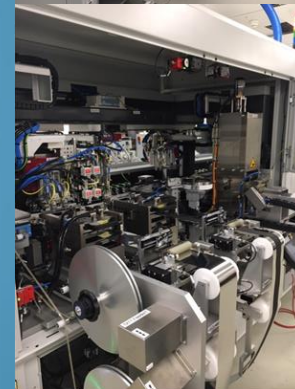
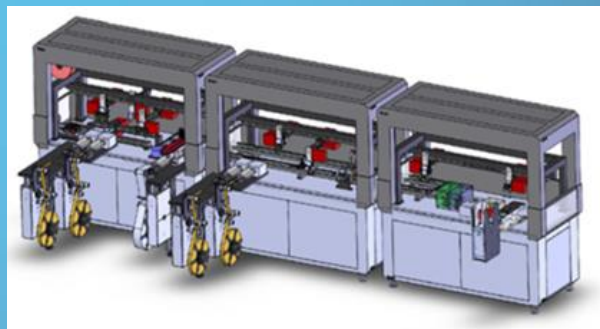
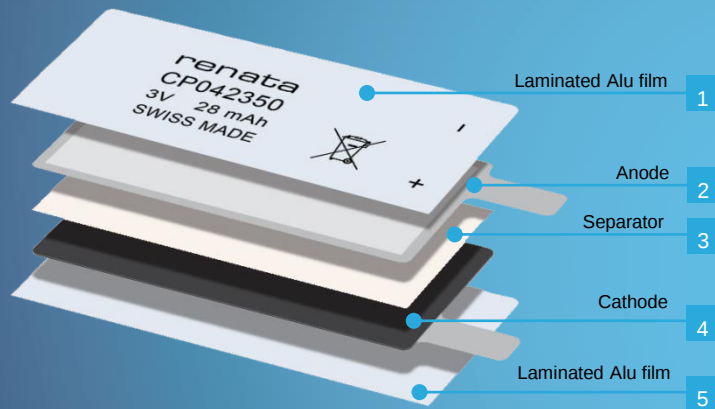
Rechargeable Coin Cells



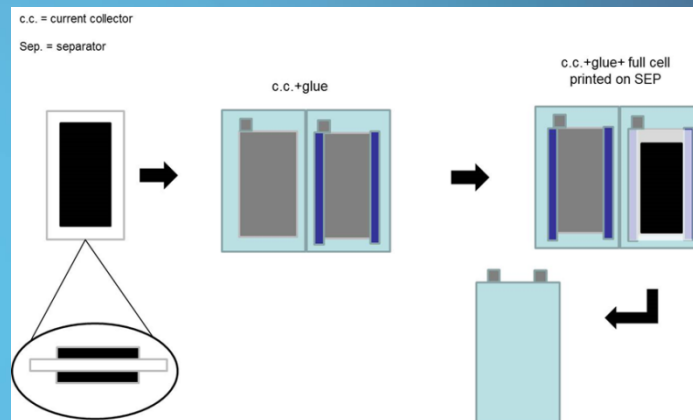
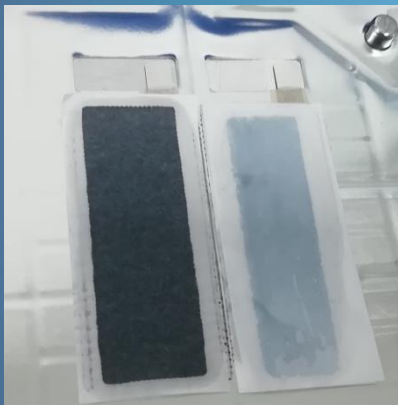
Thin Film



Thin Film – the technology for Patches



Thin Film Next Generation



Printed thin film battery – active material on separator



Thin Film and Rechargeable Coin Ideal Test Vehicle for Large Rechargeable Cells

Belenos – Target Gen 4 Technology

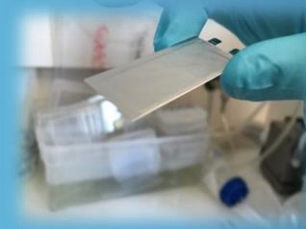
Electrical Mobility Battery Roadmap

Cell Generation	Cell Chemistry	Time
Gen 5	Li/O2 (lithium air)	>2025
Gen 4	All-solid-state with lithium anode	
	Conversion materials (primarily Li/S)	
Gen 3b	Cathode HE-NMC, HVS (high-voltage spinel) Anode C/Si	~2025
Gen 3a	Cathode NMC622 to NMC811 Anode C/Si from 5-10%	
Gen 2b	Cathode NMC523 to NMC622 Anode C	Current
Gen 2a	Cathode NMC111 Anode C	
Gen 1	Cathode LFP, NCA Anode C	

Material development in half-cell
coin cell construction

New electrode materials tested in
single cell – thin film

First stacked stability testing in
rechargeable coin cells



- Battery applications diversified to serve wearable / portable / sensor technologies, which is the basis of the Big Data Communications (IoT 4.0)
- New battery products are being developed
- Synergy between Renata / Belenos promotes faster and easier development

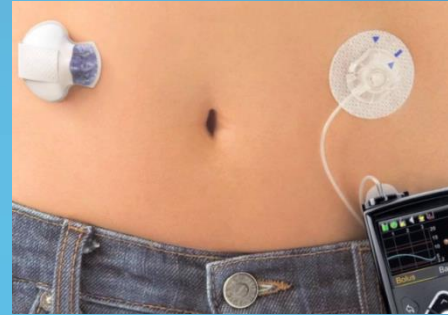
Thank you

Back-Up Slides

Battery Customers 2019



Source: IDTechEx



**Technology change to CGM (Continuous Glucose Monitoring)
drives battery manufacturers to new products!**

Belenos – Target Gen 4 Technology



Full stacked cells production and testing in different size factors for scale-up verification

