

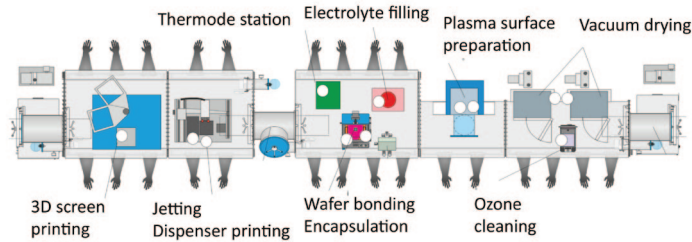
Printed stack of anode (LTO), separator (SiO₂) and cathode (NCA)

EXPERTISE AND SOLUTIONS

We propose a range of cooperation models, from direct contract research performed by Fraunhofer IZM through joining an EU, federal or national government funded scientific research project.

SERVICES

- Design and technology development for custom size lithium ion micro batteries
- Consulting and application advice for micro batteries
- Primary and secondary battery testing services
- Specialized research on battery life-time issues such as diffusion barriers, encapsulation and material compatibility. Areas of interest include higher operating temperatures, pressures, and high-g environments
- Silicon and printed circuit board expertise for battery integration and packaging
- Electrochemical test cells and material development for novel battery chemistries



Micro battery prototyping line at Fraunhofer IZM

CONTACT

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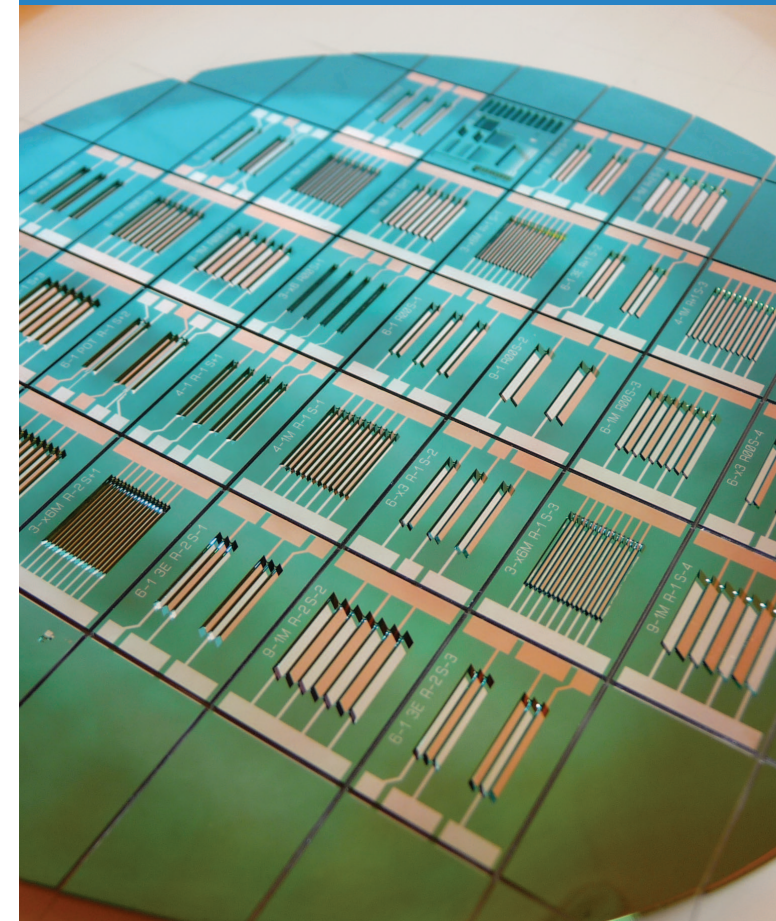
www.izm.fraunhofer.de/micro_energy_systems

In cooperation with



Cover: Micro battery fabrication on silicon wafer substrate

MICRO BATTERY PROTOTYPING





The Fraunhofer IZM's 10 m battery development and assembly line for the high-precision manufacturing of minute custom-design micro batteries

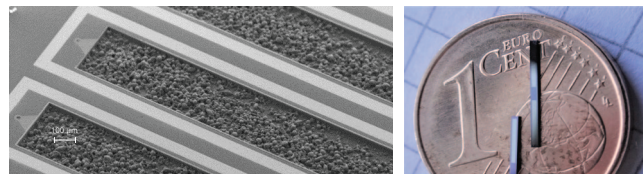
SCOPE

We aim to provide extremely miniaturized wireless power sources for applications such as implantable and semi-implantable medical devices, miniaturized data loggers, active RFID and smart jewellery. In the longer term, we aim to enable rechargeable batteries for higher temperatures up to 140 °C.

Direct battery integration in silicon saves packaging material and allows better miniaturization as well as providing a novel route for in-house small production runs. Current plans include RF and PV recharging prototypes.

CHALLENGES ADDRESSED

We build on in-house know-how of wafer-level packaging microelectronics, microfluidic electrolyte handling and battery materials processing, including the production of hermetically sealed casings under argon, to prevent humidity permeation.



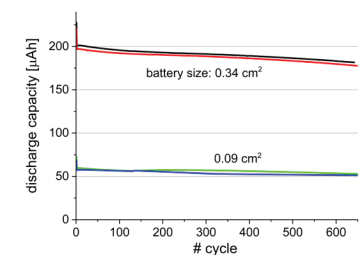
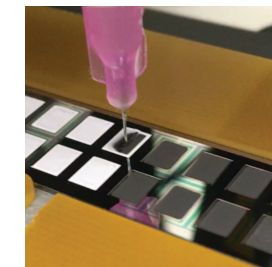
Smallest micro battery: electrodes on the silicon wafer (left) and hermetically packaged, singulated batteries 0.5 x 8 mm² on one cent coin (right)

SELLING PROPOSITION

- Prototype primary and secondary lithium-ion battery in a novel silicon package
- 1.5 V, 2.2 V or 3.7 V systems
- Minimum size is 0.5 mm x 0.5 mm x 0.2 mm (LxBxH)
- Cost between 0.4 and 4 €, between 1 and 20 mm² footprint (24 wafers production run)
- Application-specific form factor possible; any 2.5D shape
- State-of-the-art battery materials including bio-compatible electrolytes
- Cell capacity: 7 ... 30 μAh/mm² depending on electrode choice and thickness
- Energy density: 200 mWh/cm³ even with the smallest size
- Low impedance for pulse load; tested for bluetooth low energy (BLE)
- Dedicated battery management for smallest batteries
- > 750 recharge cycles demonstrated
- Safe for deep discharge
- Temperatures: 80 °C for 24 hours, -20°C ... 60 °C operation range

PROTOTYPE MANUFACTURING

- Wafer level processing including through silicon/glass vias, handling of thin wafers on carriers and wafer bonding.
- Precision screen-printing and robot dispensing for the integration of battery electrodes.
- Microfluidic electrolyte injection.
- Substrate bonding for a secure assembly and sealing of base and top substrates of the battery housing
- Simultaneous fabrication of thousand batteries on a wafer substrate.



Dispenser-printing of battery materials into silicon battery housing (left) and cycle stability at 0.5 C (right)