

# Power in System on Chip Needs a New Energy Storage Solution

## INDUSTRY TRENDS AND CURRENT SOLUTIONS ARE MISALIGNED

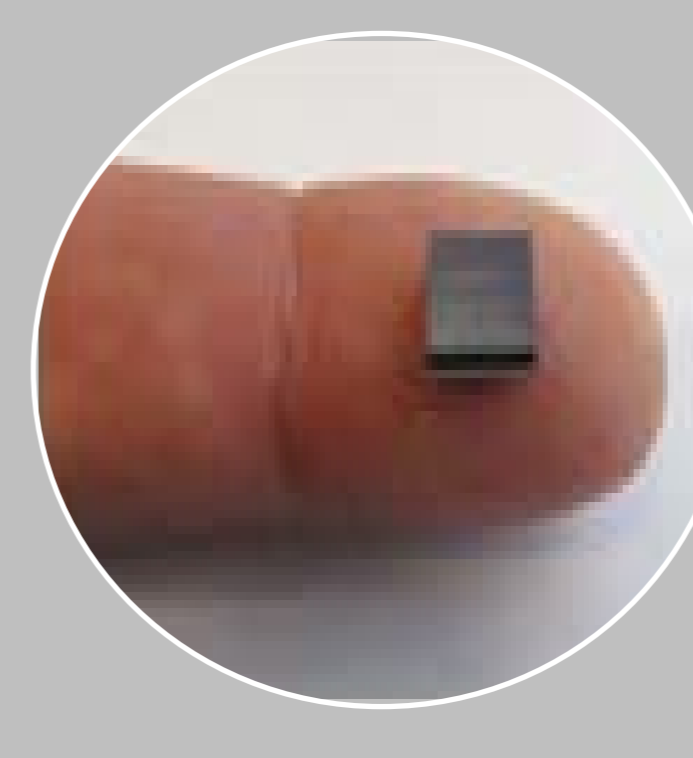
INCREASING PROLIFERATION OF ELECTRONIC DEVICES THAT ARE SMALLER, PORTABLE AND/OR CONNECTED



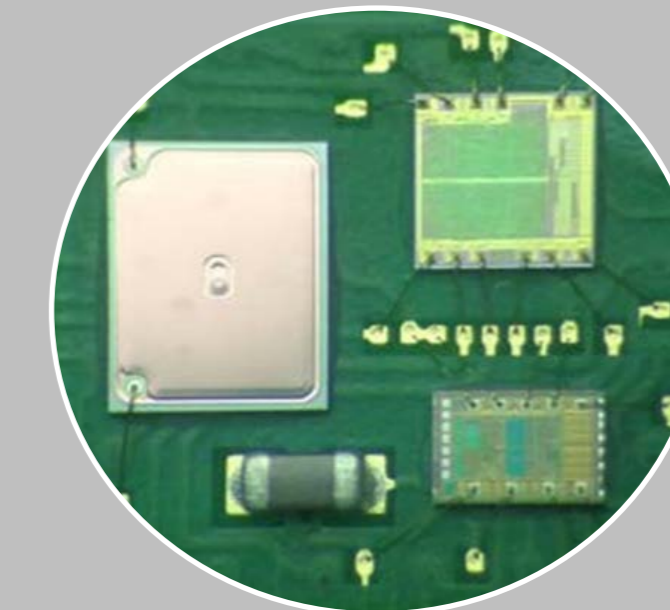
Ultra-Low Power Electronics



Wireless Smart Devices & Sensors Everywhere



Component Integration and Miniaturization



Life of Product Batteries

← **Key Trends Driving Billions of New Devices** →

HOWEVER, EXISTING ENERGY STORAGE SOLUTIONS ARE INADEQUATE



LARGER PROFILE / BULKY SIZE

LOW ENERGY FOR SPACE USED

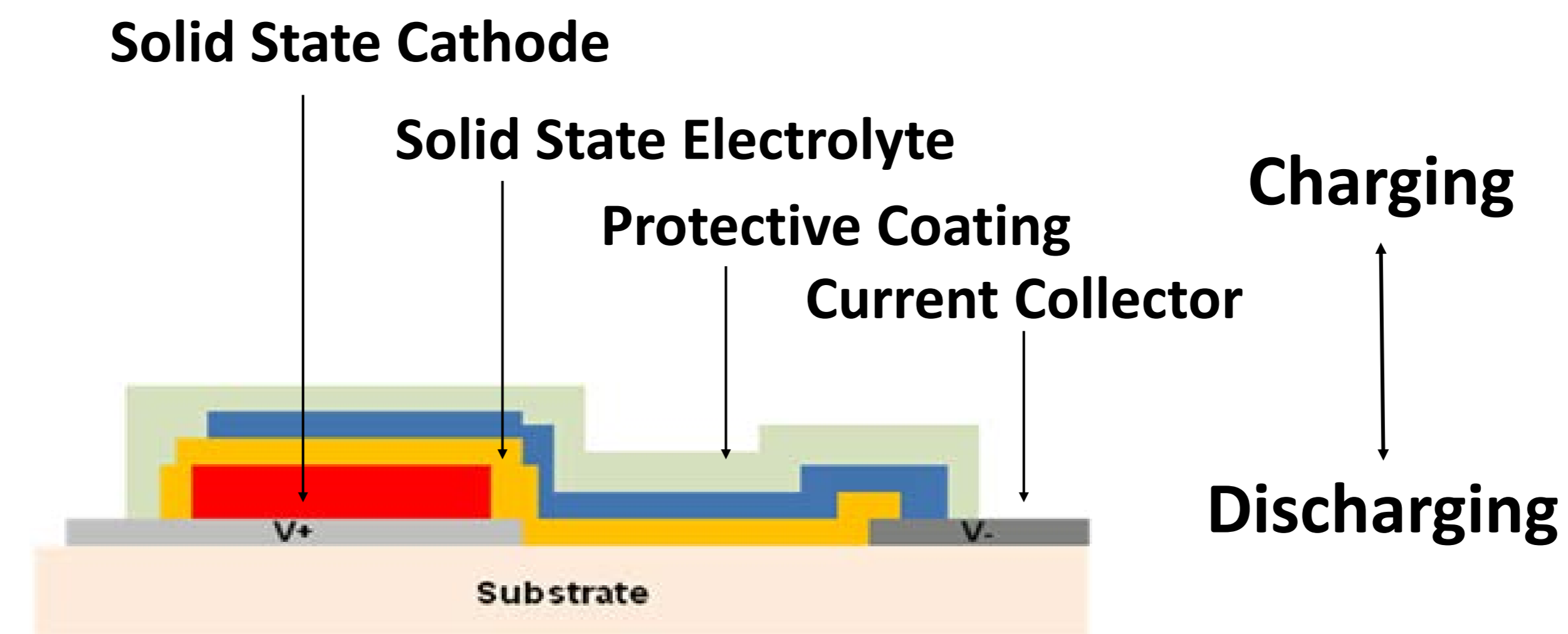
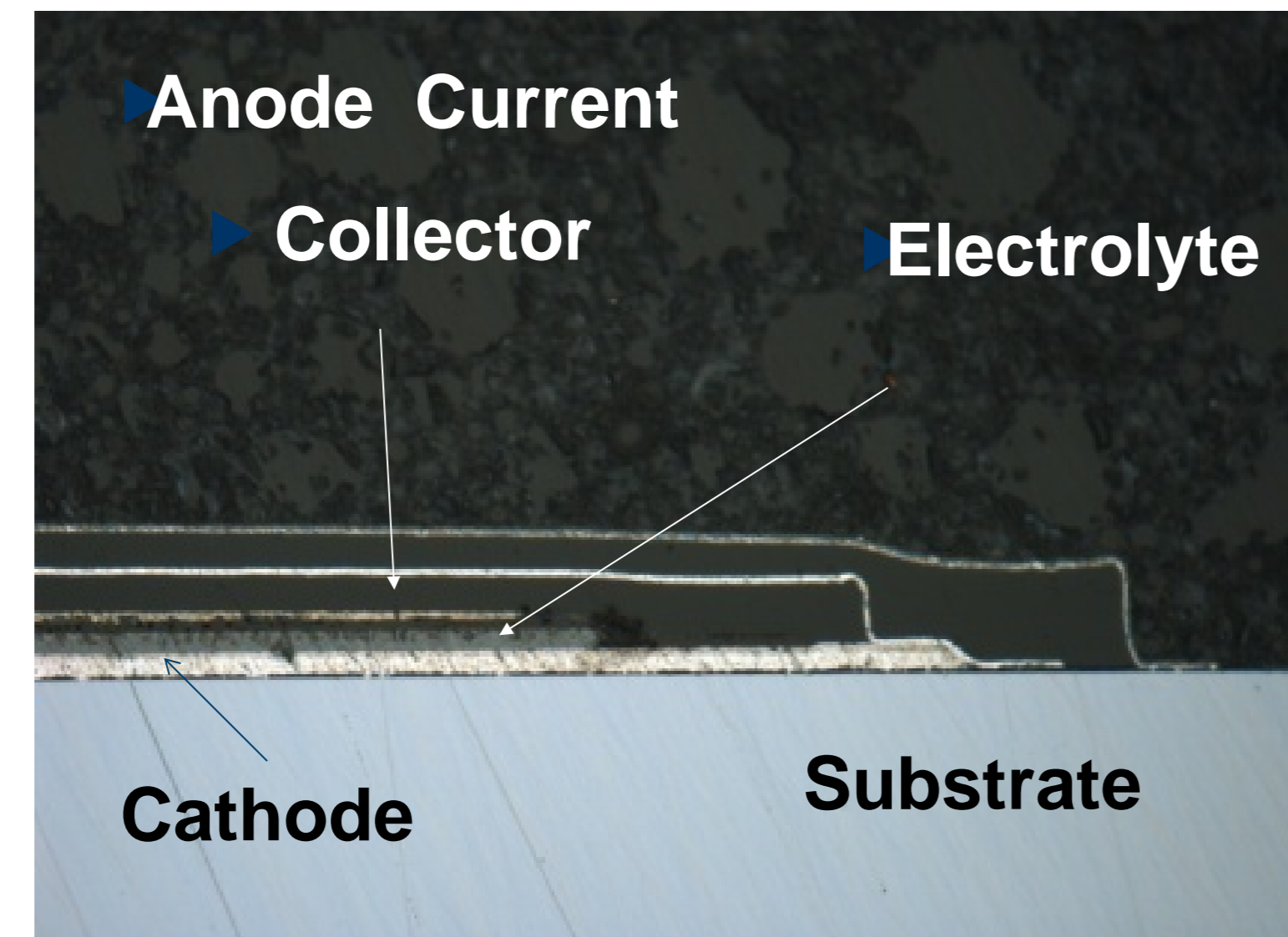
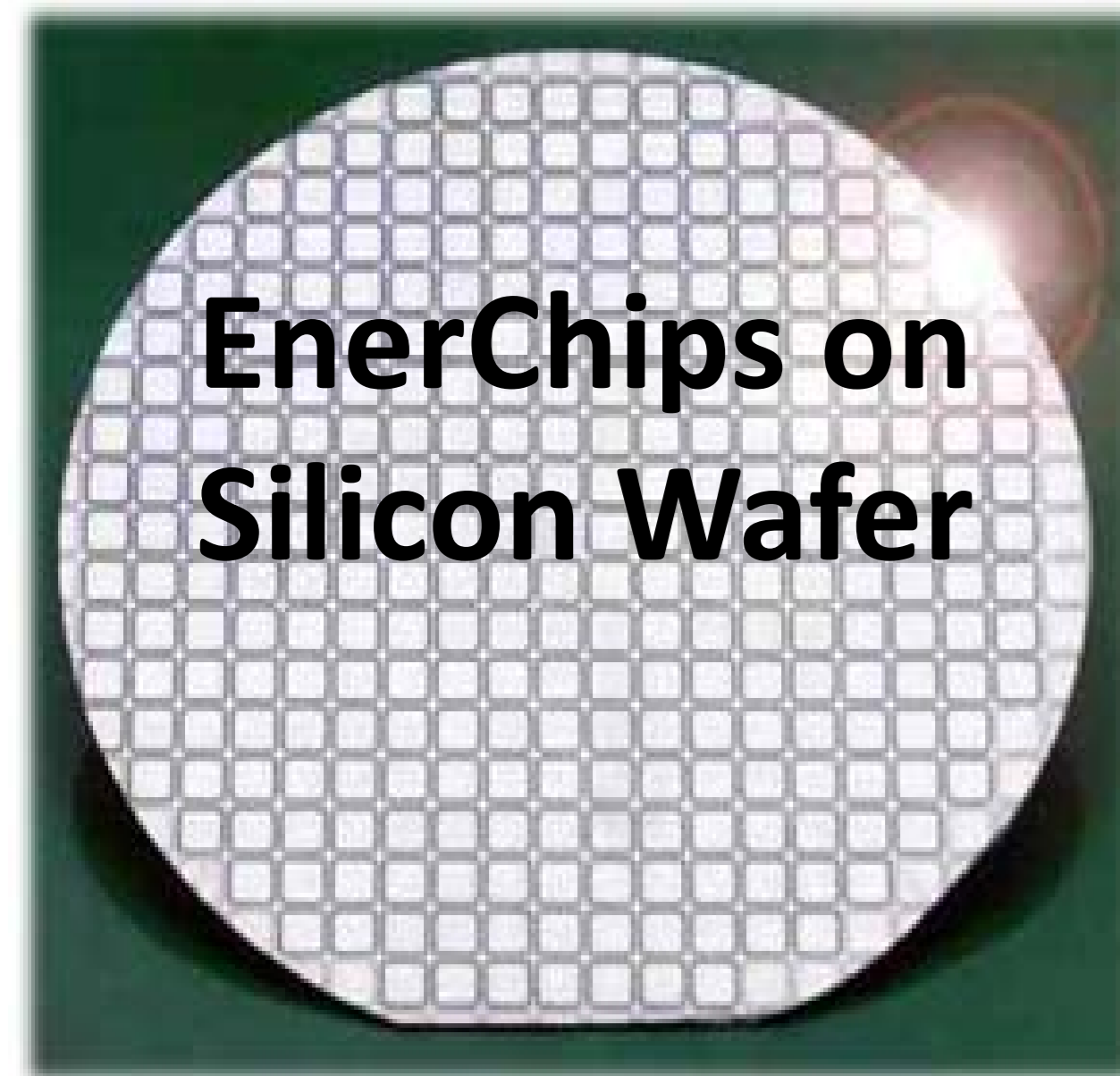
INTEGRATION ISSUES

HIGH WEAR-OUT AND FAILURE ISSUES

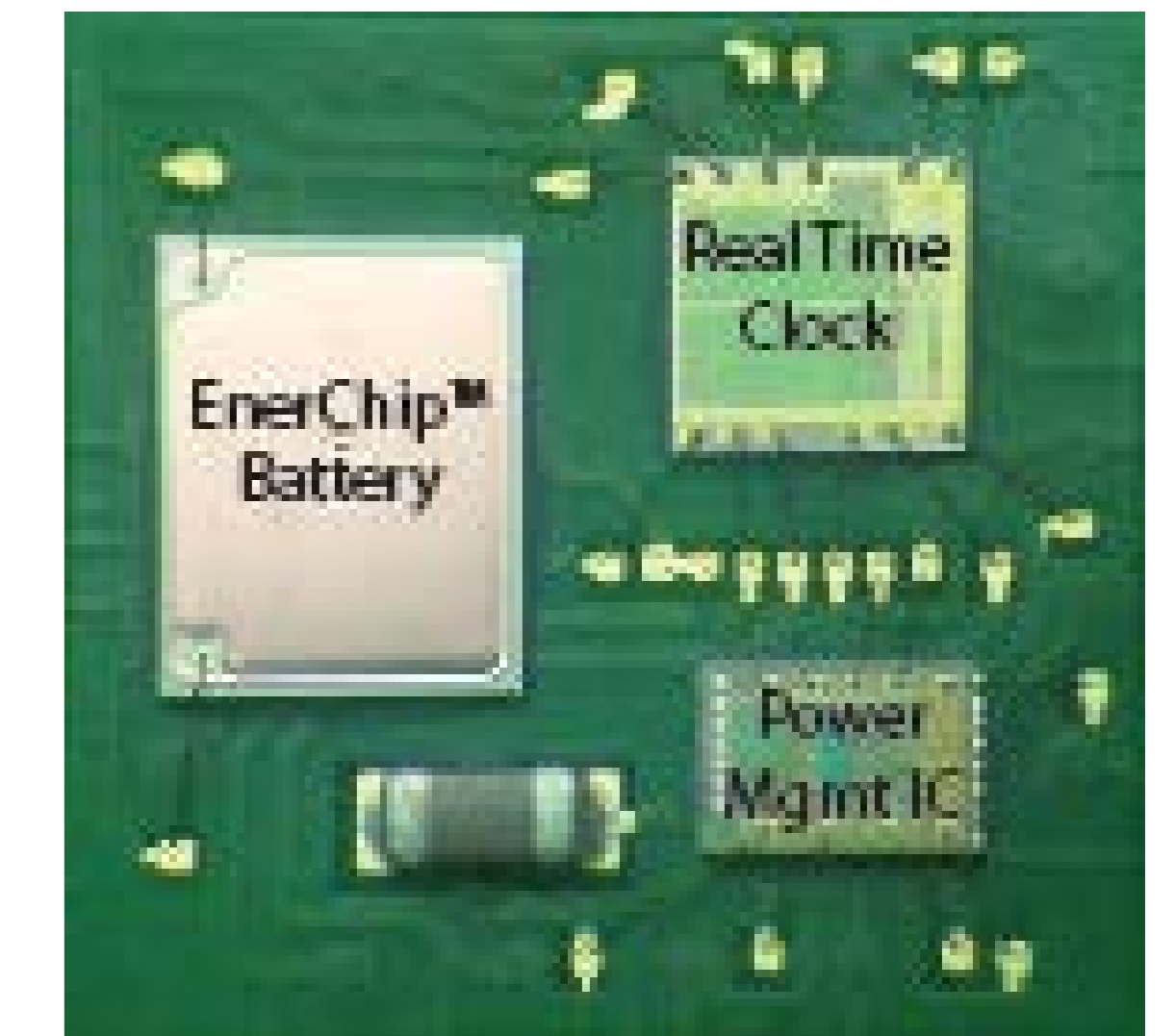
TOXIC CHEMICALS – SAFETY AND DISPOSAL ISSUES



# Cymbet EnerChip™ Solid State Battery Technology



EnerChip RTC Co-packaged  
Battery + RTC + PMIC

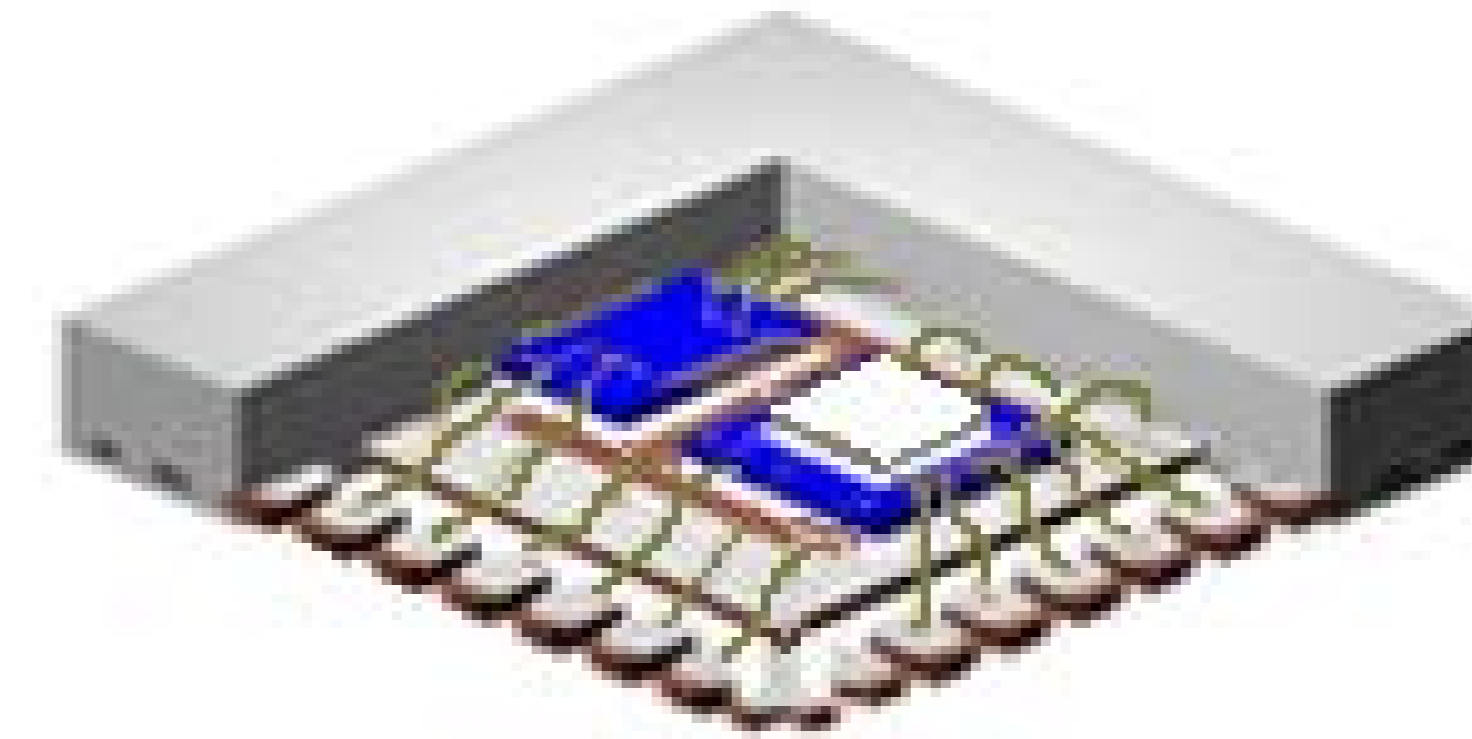


- ▶ Solid State Rechargeable Batteries in various shapes and capacities
- ▶ Produced using semiconductor fab processes on silicon wafers
- ▶ Cathode is  $\text{LiCO}_2$ , solid electrolyte is LiPON, Anode is Lithium-free
- ▶ Simple and quick 4.1V charging with >5000 charge cycles
- ▶ EnerChip battery bare die use standard wirebonds and gold stud bumps
- ▶ EnerChips are JEDEC-standard solder reflow tolerant

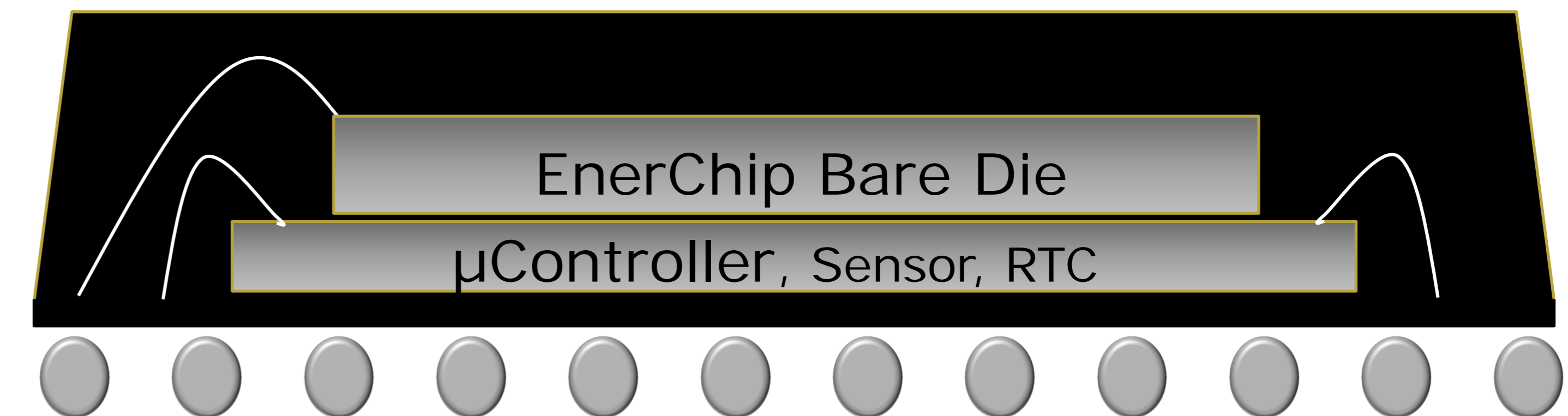


- ▶ Bare die batteries for integration into co-packaged devices and tiny modules.
- ▶ Various configurations :
  - Side-by-Side wirebond
  - Stacking – waterfall or wedding cake
  - Bumped Flip-Chip, Chip over Chip
  - Mixed attachments in System on Chip
- ▶ Applications
  - Medical Devices
  - Wearable Technology
  - Internet of Things Wireless Sensors
  - Healthcare and Fitness
  - Tamper Detection and Security

**Side-by-Side EnerChip and ICs with Wire Bond**



**Stacking EnerChip and ICs using Wire Bond**

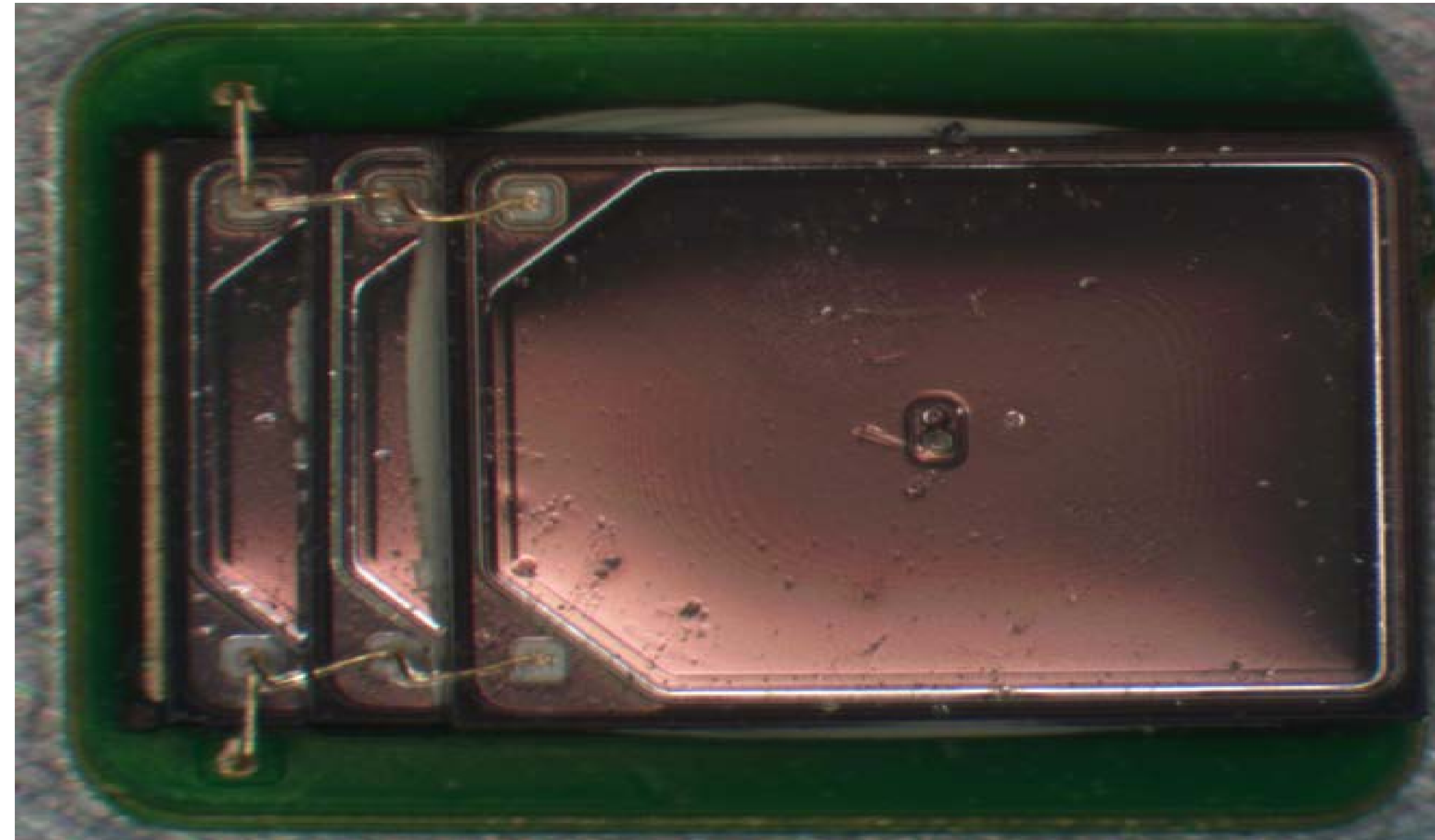


**EnerChip and ICs in System On Chip**

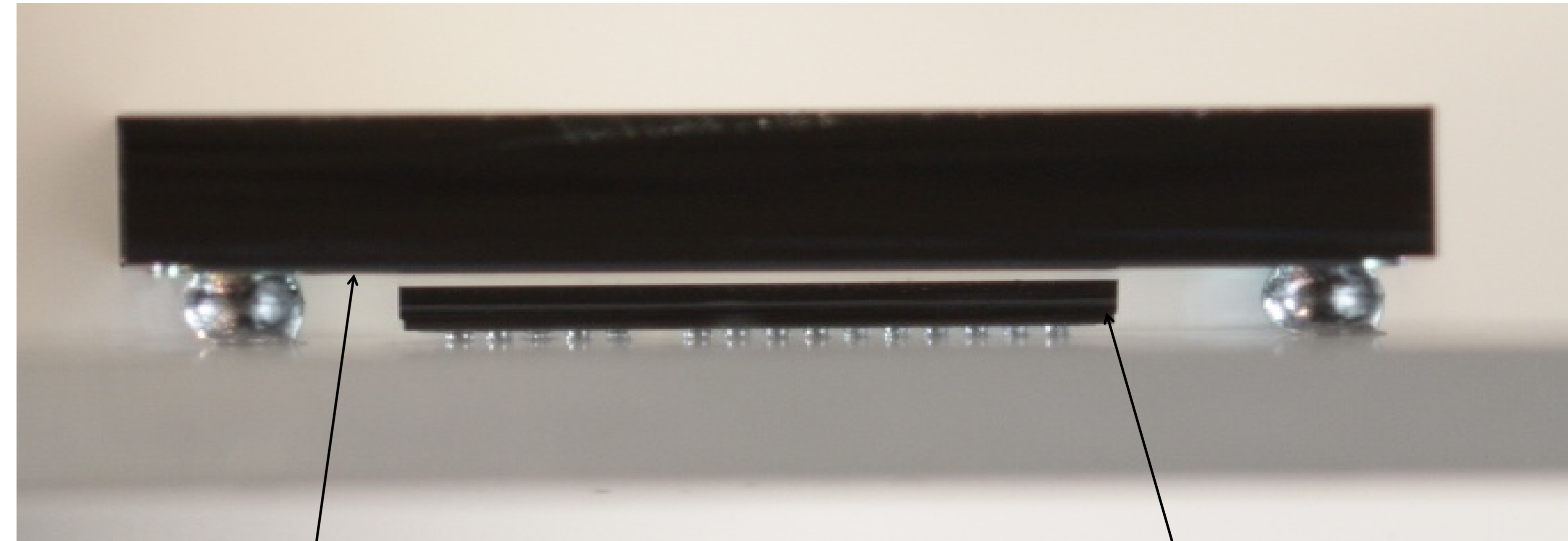




# Solid State Bare Die Stacking and Assembly Examples

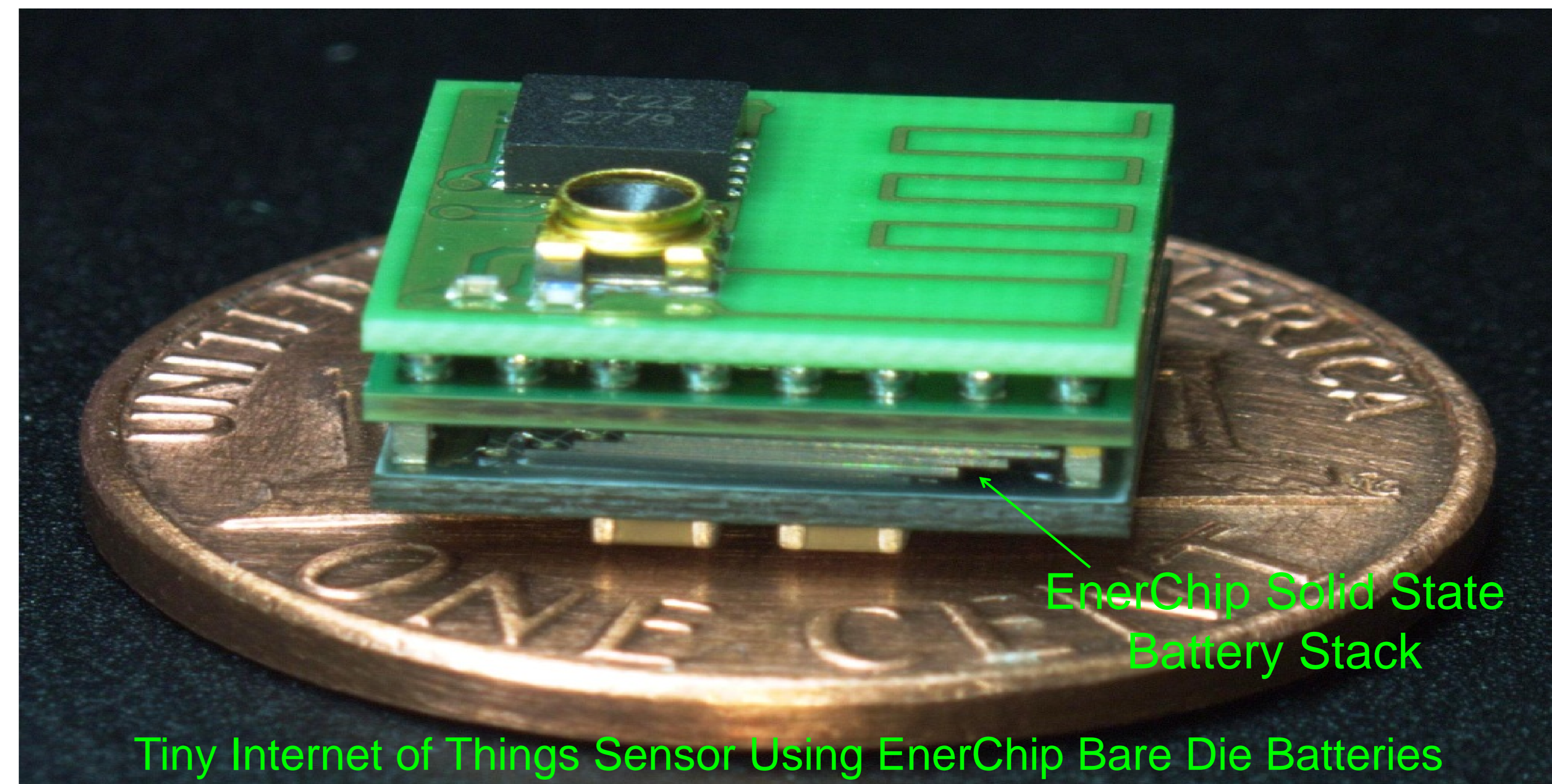


**Three Stack Waterfall Wire bond  
700 micron height**



**EnerChip Bare Die Solid  
State Battery**

**Application Specific Integrated  
Circuit**



**EnerChip Solid State  
Battery Stack**

**Tiny Internet of Things Sensor Using EnerChip Bare Die Batteries**

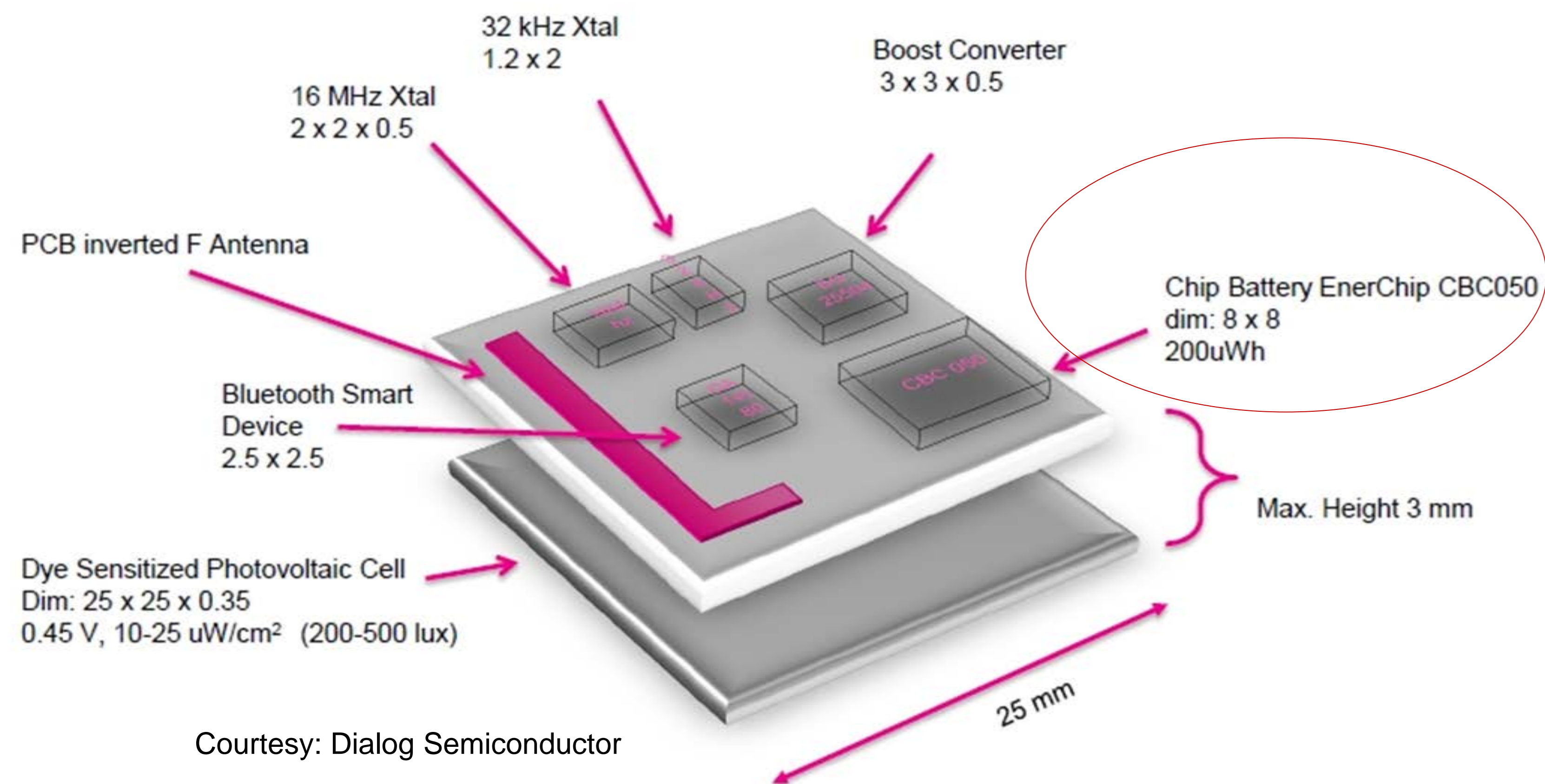


# Integrated Battery in Module Concepts – Bluetooth Smart, RFID, NFC

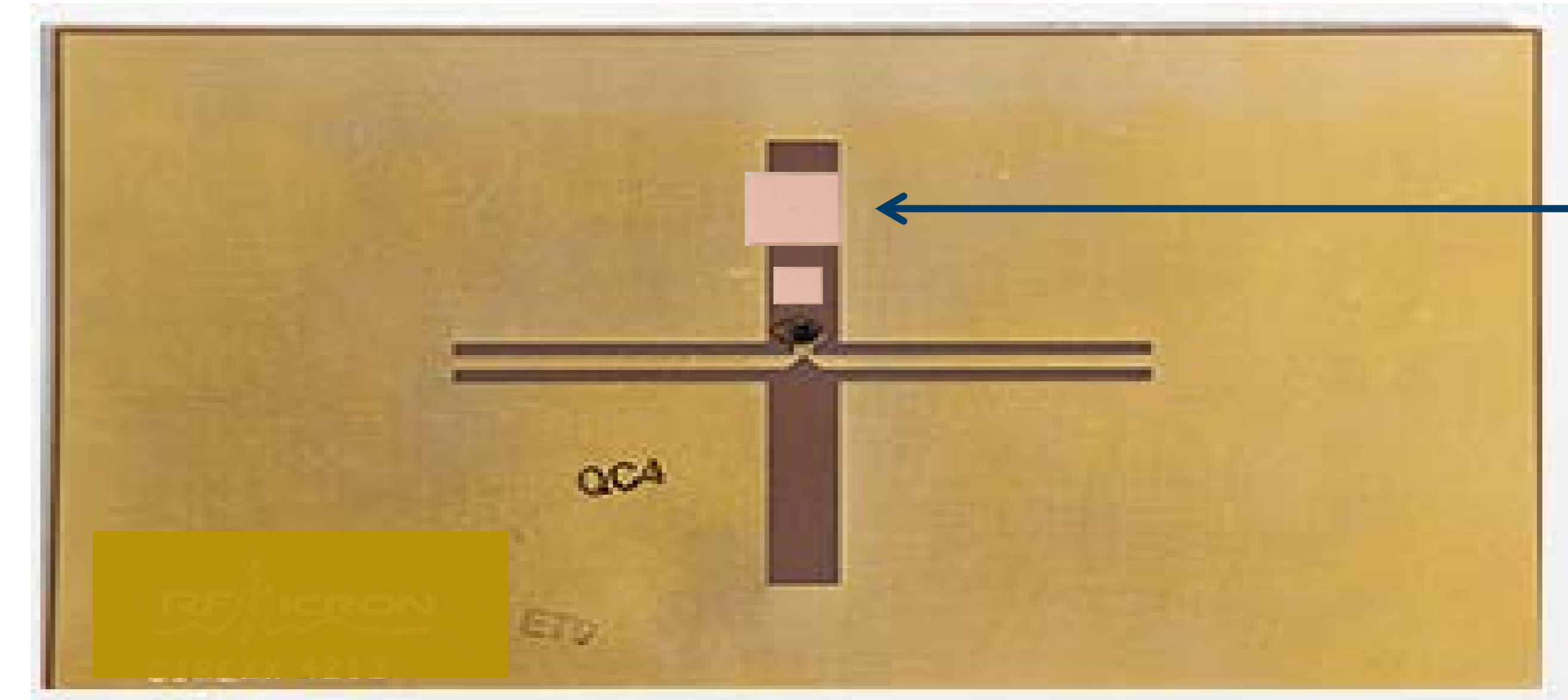
- A Bluetooth Smart beacon with a miniature solar panel that runs on room light



- Works for 2-3 hrs in the dark
- 50 hours in standby
- > 3 connections/sec at 200-500 Lux
- Chip battery charges in less than 2 hours
- Dialog Bluetooth Smart (DA14580) uses < 20 uJ/Connection

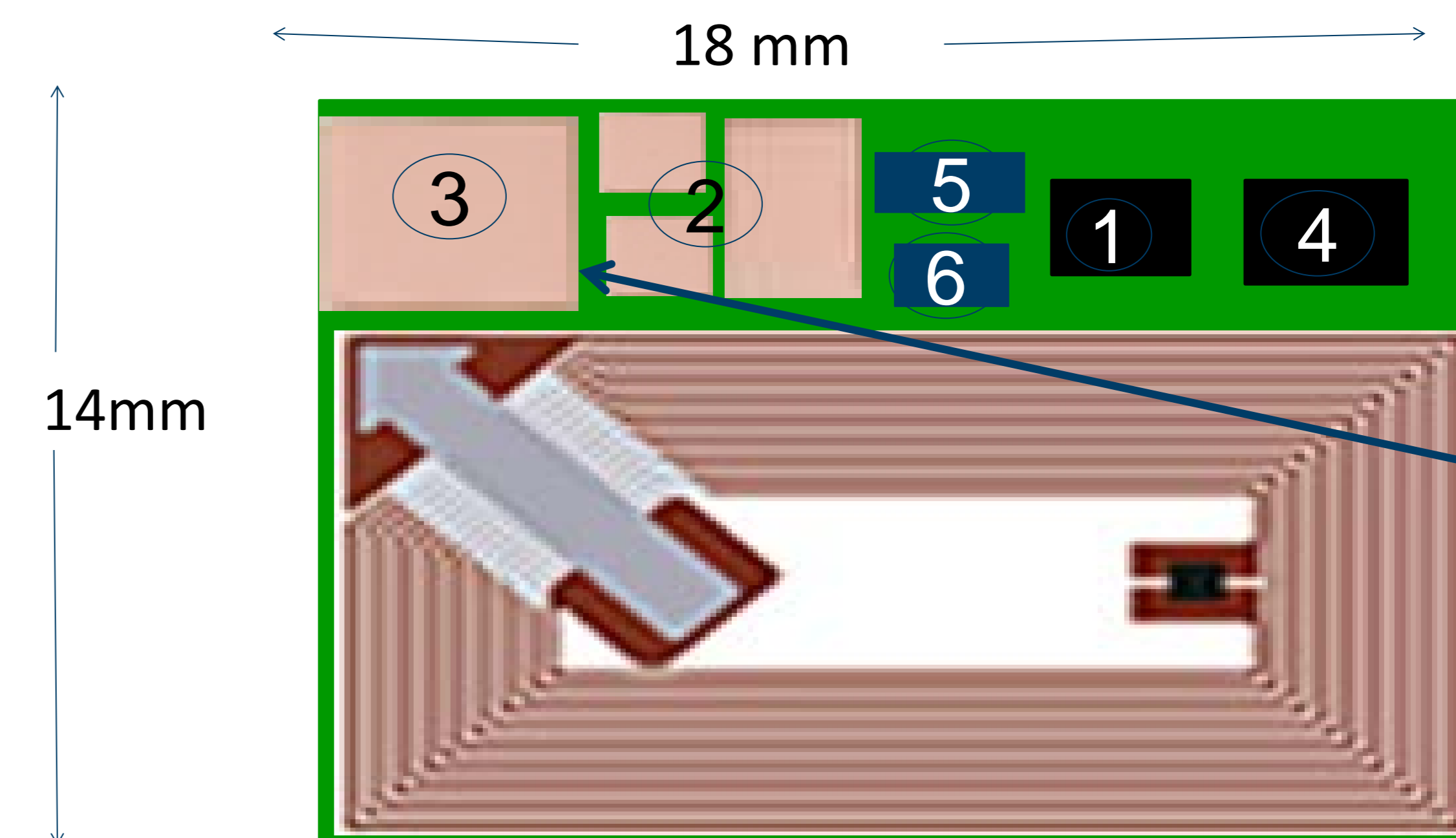


## EnerChip Powered Active RFID Tag with Bare Die



EnerChip Battery and PMIC

## EnerChip Powered IoT NFC Sensor Tag

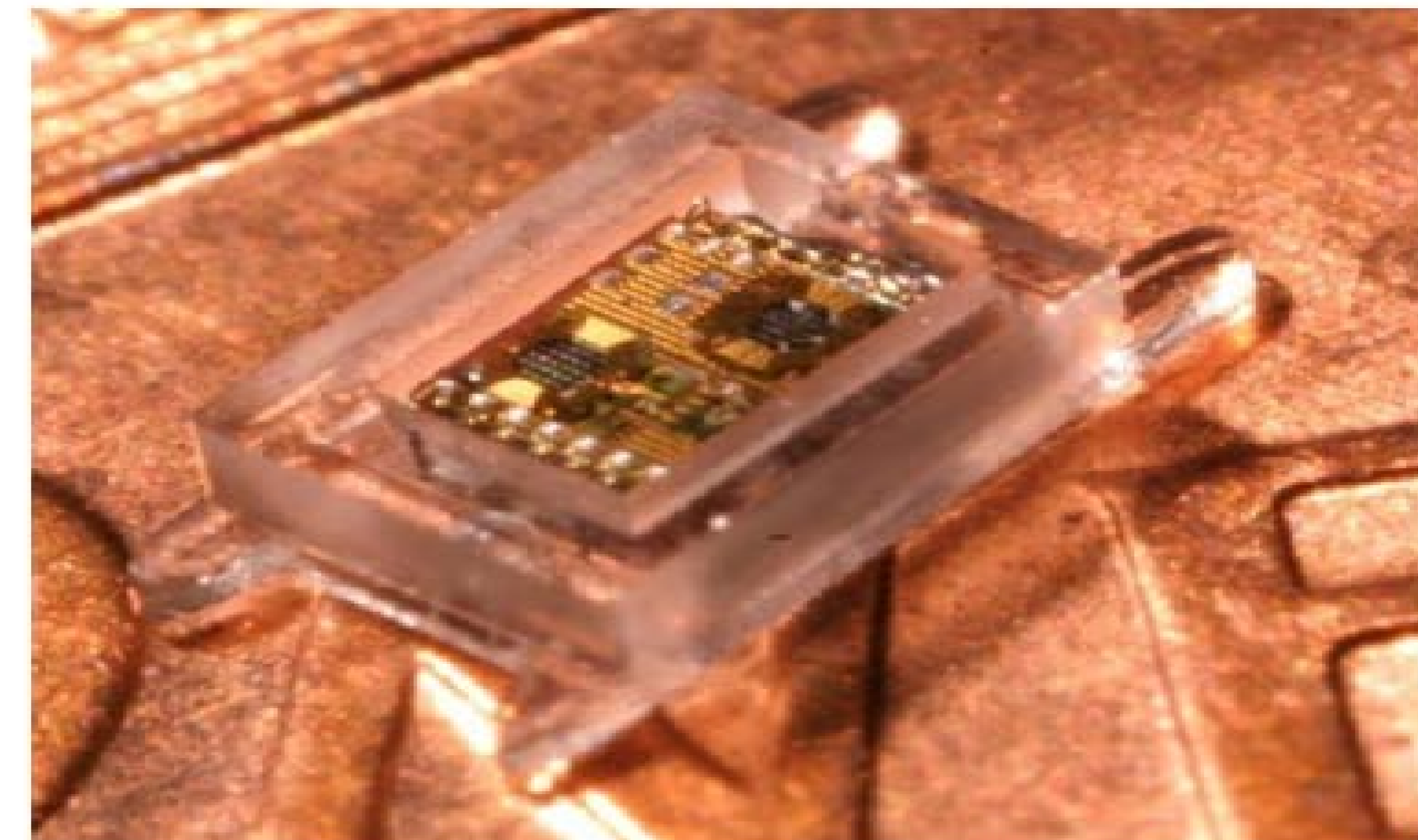


EnerChip Battery and PMIC





## Intra Ocular Pressure Sensor For Glaucoma Patients



The gamma sterilized Cymbet EnerChip™ bare die batteries were found to be non-cytotoxic (0% cell lysis) using both the Medium Eluate Method Eluation Test and Agar Diffusion Test feasibility screening procedures. The lack of any adverse biological responses in these very sensitive in vitro cell culture assays is indicative (although not a guarantee) of biocompatible test results in the other in vitro and in vivo aspects of biocompatibility as suggested by the ISO 10993-1 and FDA G95-1 guidelines.

