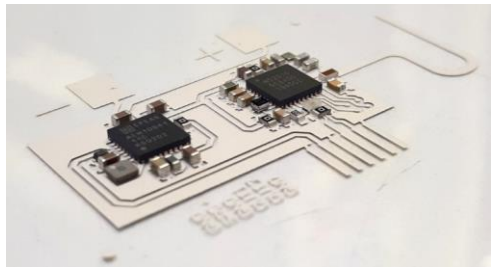
Smart2Go

Smart2Go Tangible Results

Smart2Go Energy Supply Platform

Energy storage
- Rechargeable battery (Li-ion cell, NiMH,..)
- Supercapacitor
- Wireless charging module

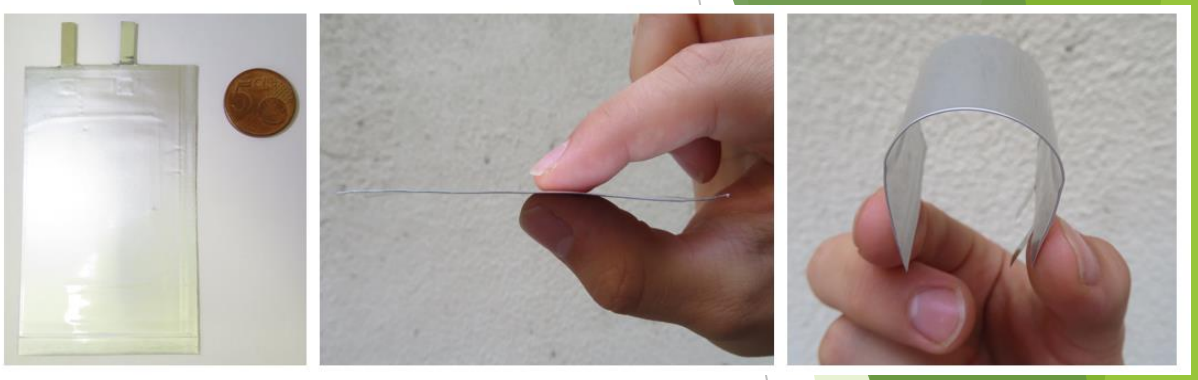
Energy harvesting
- Any type of solar cell
- Piezoelectric
- Thermoelectric generator



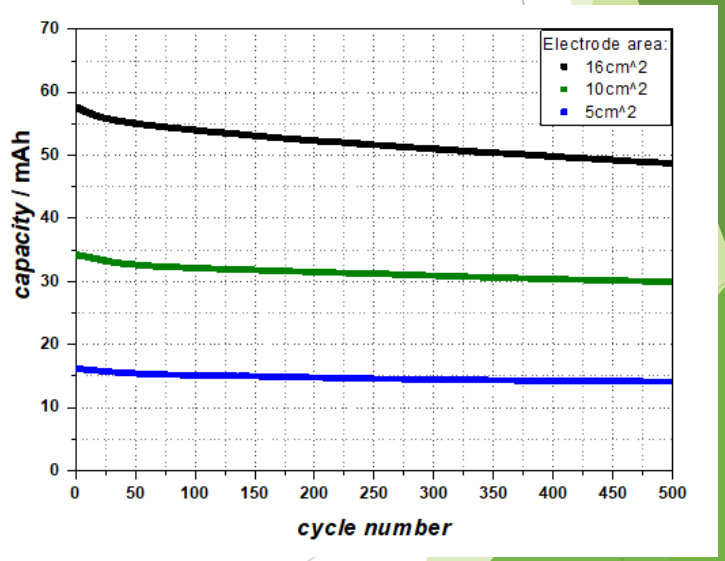
External devices
- Integrated lighting sources (OLED, RGB-LED)
- Digital I2C sensors, e.g.
  - Color and ambient light
  - Liquid flow
  - Gas /indoor air quality
  - Humidity/temperature
  - Ultrasonic range finder
  - Pressure
  - Inertial measurement unit (accelerometer, gyroscope, magnetometer)
  - Passive infrared

Thin Film Flexible Battery

- **Type:** Single Layer Pouch Cell
- **Chemistry:** Graphite vs. NMC622
- **Nominal Voltage:** ~3.7V (average)
- **Thickness:** <500 µm
- **Size:** different cell sizes and capacities possible



Electrode size [cm^2]	Overall cell size [without tags)	Nominal Capacity [mAh]
16	75mm x 50mm	55
10	50mm x 32mm	35
5	32mm x 31mm	17



Cycling results over 500 cycles (c-rate: 0.5C)

Excellent cycling behaviour at room temperature @0.5C charge/discharge
→ Cells > 80% capacity retention after 500 full cycles

Supercapacitor

Series connected supercapacitors: Fabricated as part of energy supply platform. Super P high conductive carbon black ink, non-aqueous organic electrolyte propylene carbonate and carboxymethyl cellulose binder were used for the fabrication.

Specifications:

- Size: 5 cm by 6 cm
- Capacitance: 3-5 mF
- ESR < 3 Ω
- Input voltage: 2.5V/cell

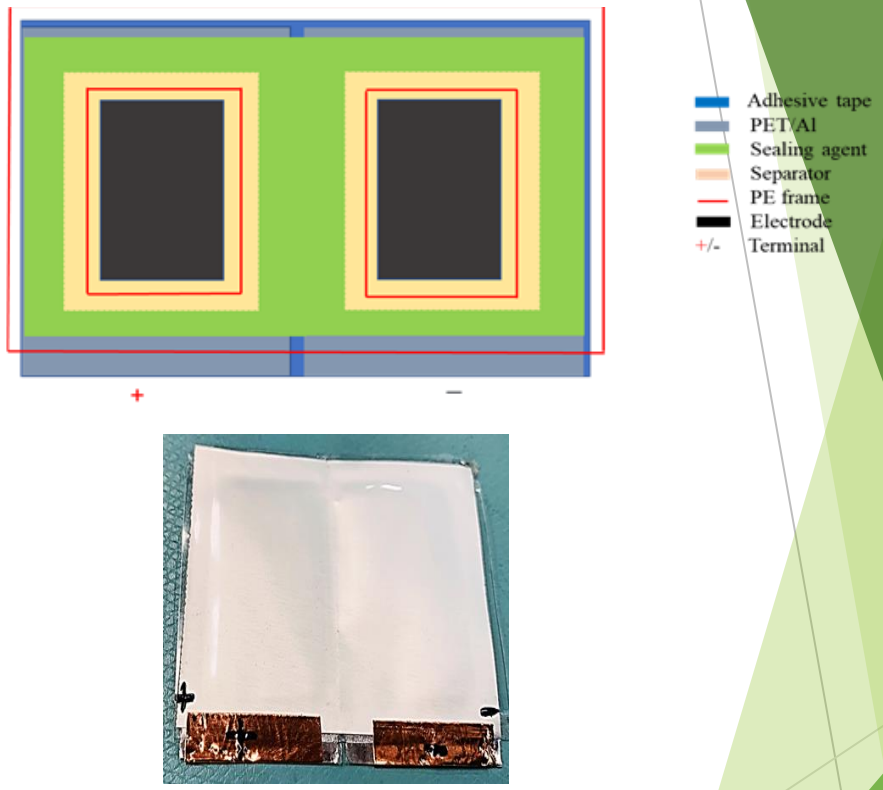


Figure 1 : Schematic structure and fabricated supercapacitor

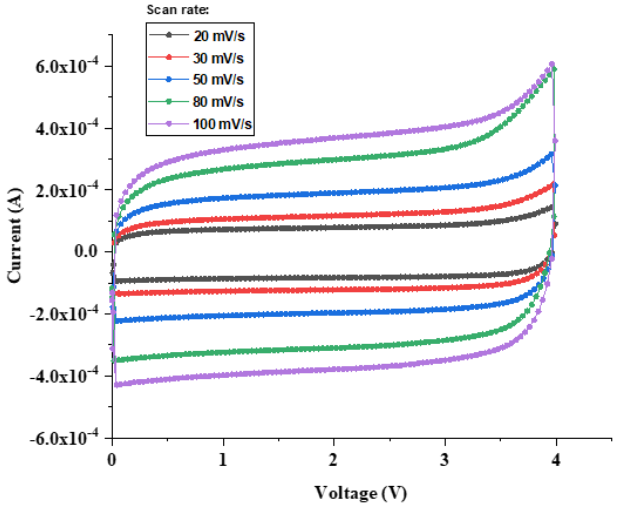


Figure 2 : Cyclic voltammetry measurement

Smart2Go – Energy harvesting with OPV

Flexible OPV modules:

- PET flexible substrate
- Roll to roll coated layers
- Organic materials
- Adjustable size and design
- 290 µm thick

Application integration:

- Design (size and number of cells) adapted to the product
- Crimps and cables aligned with the application
- Operating temperature : -10°C to 60°C
- Bending radius 15mm

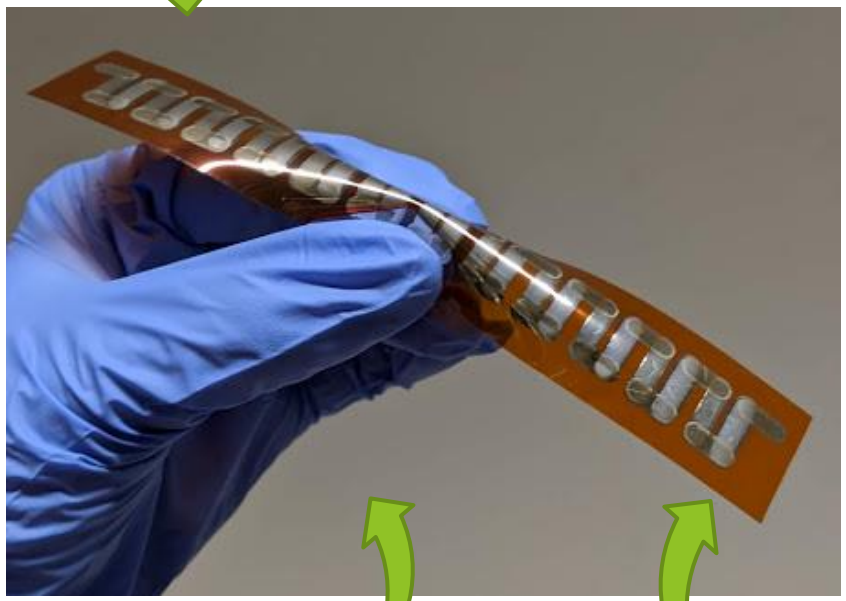
OPV performance:

- Power output 48W/m² under 1000W/m² illumination
- >6µW/cm² under 200Lux illumination

Smart2Go – Generating energy from body heat

Flexible Thermoelectric Generators:

- Polyimide substrate
- Sputtered thin films
- Bi_2Te_3, Sb_2Te_3
- 135 µm thick, 13 cm^2



Application integration:

- Access to temperature gradient required
- Integrating multiple generators in parallel or series allows voltage and current tuning
- 12 generators electrically in series and thermally in parallel delivers areal power density 2.8 µW/cm^2 for a 25 °C temperature difference

Single generator performance:

- 5 °C temperature difference produces 4 mV of open circuit voltage, 38 µA close circuit current and power of 0.15 µW
- Increasing the temperature difference to 25 °C raises the power output to 4.3 µW

Smart2Go
– demonstrating a smart safety garment

Illumination

- OLED stripes
  - 2 on front
  - 2 in the back
  - 1 on cuff

Heart of the system

- Energy Supply Platform unit
- Battery for energy storage

Energy harvesting

- Organic solar cell modules
  - 2 on front
  - 2 in the back
- Piezoelectric sensor
  - 1 by the elbow (in lining)
- Thermoelectric panel
  - 1 on chest (in lining)

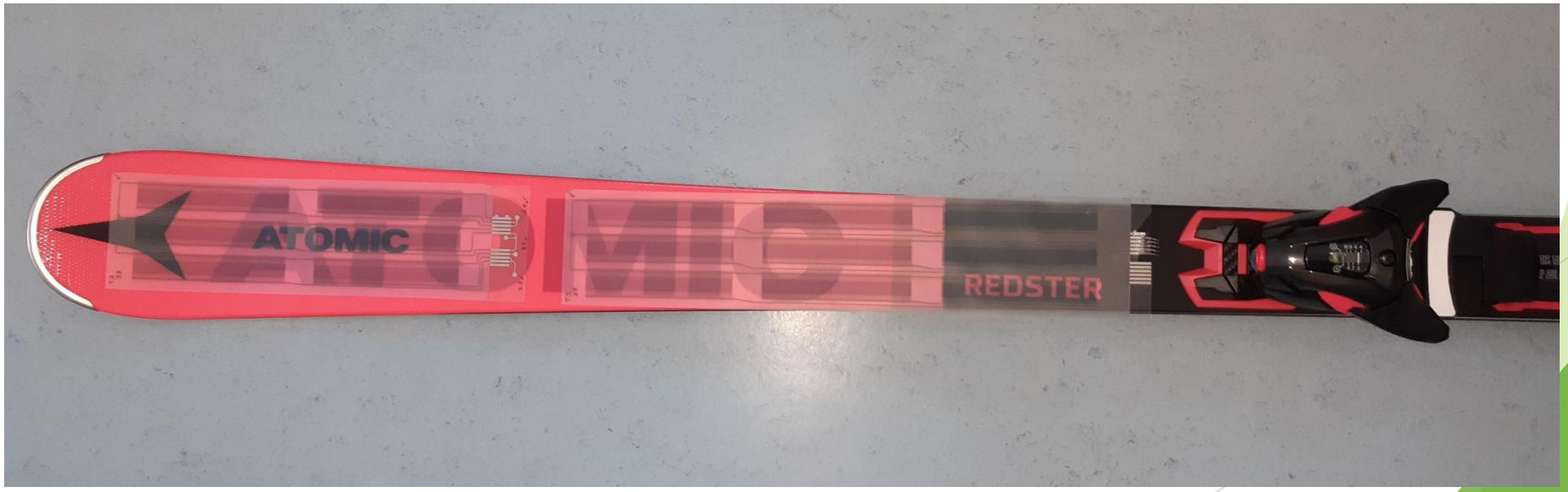
Energy delivery

- Flat cables
  - Encapsulated in clear plastic pockets to ensure waterproofness
- Switch & wireless charging

Sport equipment demonstrator

PIEZOELECTRIC SENSORS AND ENERGY HARVESTER by JOR:

- based on ferroelectric polymers (stable, UV and weather resistant, high durability)
- printable on different substrates (plastic, paper, glass, textile, metal) at industrial scale (cost-effective screen printing method)
- large area and low thickness (6µm)
- accurate measurement of temperature and pressure changes
- mechanical deformation generates electrical energy
- easy integration with the Smart2Go Energy Supply Platform
- customized sensor system containing the sensor design (e.g. sensor foil), electronics (PCB), software for data acquisition, application specific analysis and user interface



Sport equipment demonstrator

ASSEMBLY, TESTING AND VALIDATION by ATO:

- Temperature range in operation: -30°C - +5°C (23°C in the lab)
- Temperature range during shipment/storage: -25°C - +75°C
- Environmental conditions: UV, salt/saline solution/steam water
- Main strain/compression: 0,5% on total length of ski
- Bending cycles without delamination (ISO 6266): 20.000
- Operational lifetime: 200 working days per year over 3 years and 10 hrs each