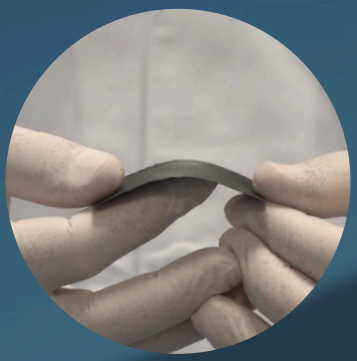
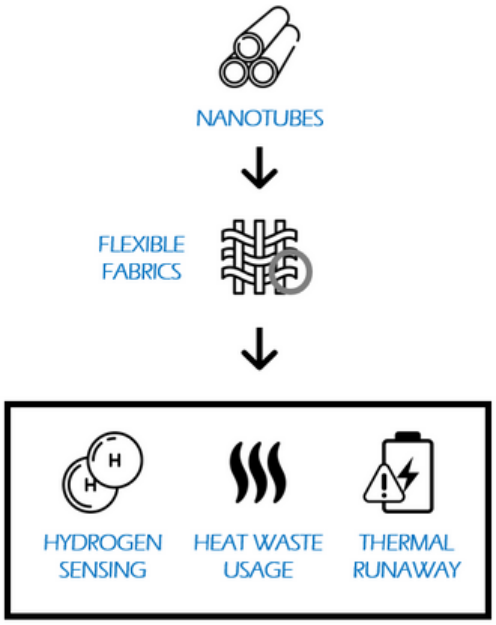


THERMOELECTRIC NANOSTRUCTURED FLEXIBLE FABRICS

FOR HYDROGEN SENSING, THERMAL RUNAWAY DETECTION AND POWER GENERATION

IREC
Shaping Energy for a Sustainable Future

THE CONCEPT



ADDED VALUE

- Adapts to any hot surface
- High performance
- Good mechanical properties
- Self-powered

TRL

5

PATENTED

CONTACT

https://irec.cat
KTT area
ktt@irec.cat
+34 933 562 615

PRODUCT DESCRIPTION

- **Thermoelectric flexible fabrics** made of nanotubes which can **adapt** to any hot surfaces
- Very **light** and **thin**
- Based on non-toxic and abundant raw materials
- Uses waste heat to function
- Flexible, light, and highly stable at high temperatures
- Can be mass-produced at **low-cost** with already existing manufacturing industrial processes
- Application in a sensitive self-powered thermoelectric **hydrogen sensor**

APPLICATIONS

- Energy harvesting from heat waste
- Power IoT nodes in industrial environments (industry 4.0, chemical industry, petrochemicals or automotive sector)
- Hydrogen sensor
- Thermal runaway sensor in electric vehicles or second-life batteries storage

DESIRED PARTNERS

- Industrial partners, IoT manufacturers, system integrators
- Battery manufacturers
- Companies using large-scale CVD

EXPECTED BENEFITS

technical details

APPLICATION DETAILS

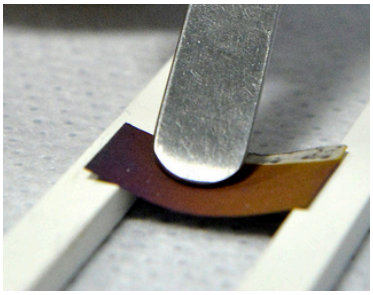
The silicon nanotubes combine the high electrical conductivity of silicon with limited thermal conductivity thanks to its nanostructured nature to obtain the highest figure of merit possible.
It has been tested and fabricated in IREC's laboratories, and the production process employs well established mass manufacturing techniques like electrospinning and CVD. Other relevant features that arise from the material's architecture are its lightness, the ease with which it adapts to multiple geometries, its flexibility and the stability that it has, even at high temperatures (700°C).
A self-powered hydrogen sensor has been fabricated by depositing a catalyst on the fabric, which triggers the oxidation of hydrogen, locally releasing heat. This heat is then converted into power. It is capable of detecting up to 250 ppm of hydrogen at room temperature. This technology can be used for thermal runaway detection in batteries, since hydrogen is released during this process.

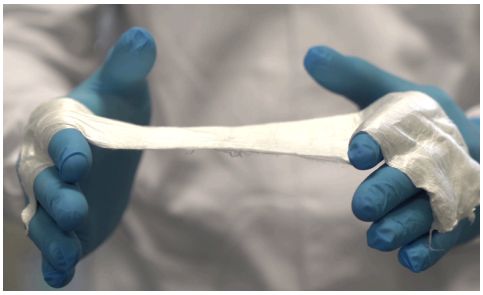
THERMAL RUNAWAY DETECTION

Battery safety is becoming more important due to the growth of the battery market. Before an explosion occurs, hydrogen is released and our technology could detect the hydrogen released during the thermal runaway and so prevent hazardous consequences. The ultra-low current consumption and the high rate of diffusion of hydrogen are an advantage compared to current solutions, since its reliability is not expected to depend on its position relative to the triggered cell.

The main figures of merit of this hydrogen sensor are:

- **Limit of detection**: 250 ppm at RT, 50 ppm at 100 °C
- **Selectivity**: Demonstrated selectivity towards CH_4 and DME
- **Response time**: 40 s at RT, 15s at 100C
- **Power density generation**: 0.5 μW cm^{-2} at RT and 2.75 μW cm^{-2} at 100 °C





Adaptable to any surface shape

Patent number: EP3306685