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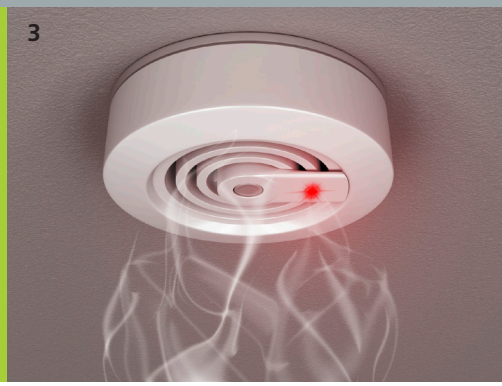

1 *Surveillance camera*
(© Pixinoo - Fotolia.com)
2 *Weather station*
(© emeraldphoto - Fotolia.com)
3 *Smoke detector system*
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LONG LIFE MICRO POWER UNIT

Motivation

Off-grid power systems are widely spread throughout automation, environment and security technology, where a few watts of electrical power are needed

- over a longer period of time,
- with interrupted operation and/or
- at harsh and varying environmental conditions.

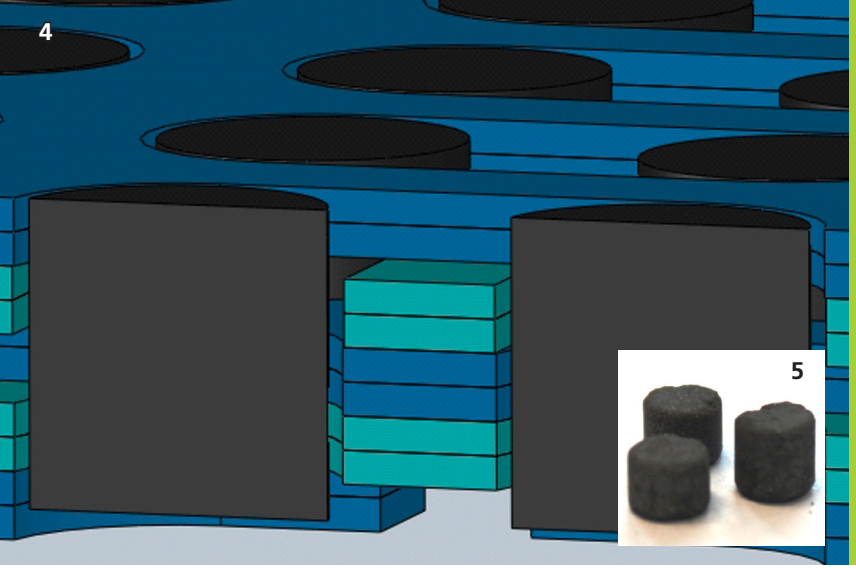
Nowadays, such systems are usually equipped with batteries. Hydrogen fuel cell-based power supply offers several advantages:

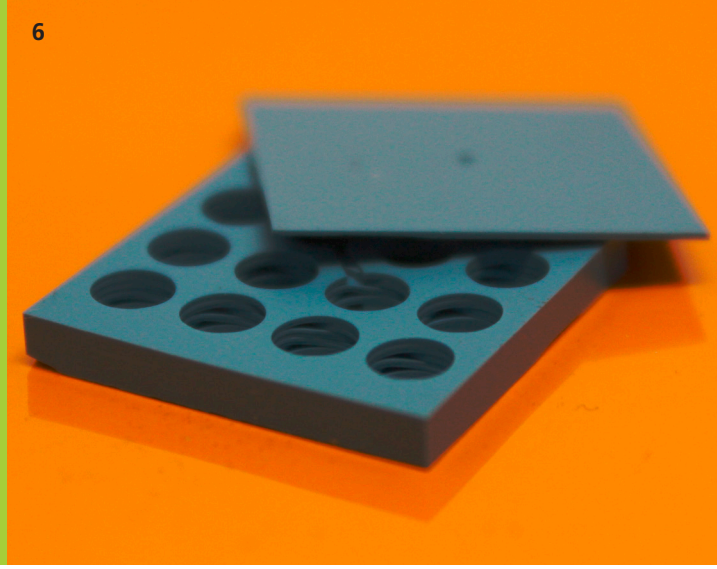
- Small size
- High energy densities (cf. Table 1)
- Many recharge cycles
- Low maintenance effort
- No self-discharge
- No energy losses due to temperature variations

Fuel cell systems with a solid-state hydrogen storage integrated in a monolithic ceramic tank allow for a highly compact design. Thus, durable power units with a high efficiency can be achieved.

Micro Power Unit	**CR2450 (rechargeable lithium button cell)**
FC system with integrated solid-state hydrogen store:	Electrochemical storage
• 22.5 x 22.5 x 5 mm³ = 2.5 cm³	• Ø 24 x 5 mm³ = 2.3 cm³
• 16 compartments with storage material ⇨ $m_{storage\ material}$ = 16 x 0.15 g = 2.4 g ⇨ $m_{hydrogen}$ = 2.4 g x 1.5 wt.%H_2 = 0.036 g ⇨ $E_{hydrogen}$ = 0.036 g x 33 Wh/g = 1.2 Wh	• 120 mAh at 3.6 V ⇨ E_{el} = Q x U
• FC effenciency: 60%	
• Electrical energy: 720 mWh	• Electrical energy: 430 mWh
• 290 Wh/l	• 190 Wh/l
• Cyclability >1000	• Cyclability < 100

Table 1 Comparison of energy densities





Applications

- Sensor devices (e.g. weather stations)
- Long-term security surveillance
- Portable electronics
- Medical devices

Detailed Information

The Micro Power Unit is based on a micro-PEM fuel cell which is manufactured by ceramic multi layer technology (LTCC; cf. Fig. 1) allowing to integrate the hydrogen solid-state store. Thus, an intimate contact between the energy converter and the storage unit is achieved.
Compacted metal hydrides are used as a solid-state hydrogen storage material. Therefore, several benefits are realized:

- High energy densities due to a high volumetric storage capacity of hydrides (cf. Table 1)
- Fast loading and (if necessary) unloading of hydrogen at temperatures between -10°C and 40°C (cf. Fig. 2)
- Moderate pressure requirements (~30 bar H_2)
- Exhaust heat of the fuel cell is used for the endothermic dehydrogenation reaction, thus, the overall efficiency is increased
- High integration level allows robust and durable use like batteries

4 Schematic view of the LTCC tank architecture with metal hydride compacts
5 Metal hydride compacts with a diameter of 4 mm
6 Hydrogen tank compartment (22.5 x 22.5 x 2.5 mm³)

Fraunhofer R&D Services

- Customized development of power units with regard to
  - Power input and output
  - Energy capacity
  - Environmental requirements
  - Charging equipment
- Development of materials processing and implementation technologies
- Design, construction, test and evaluation of micro power units
- Cycling tests for life-time evaluation
- Safety and reliability tests
- End-of-life processing

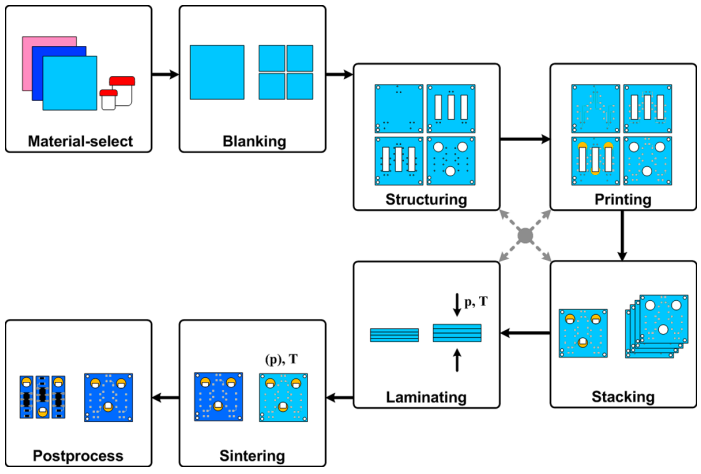


Fig. 1 LTCC technology processing route

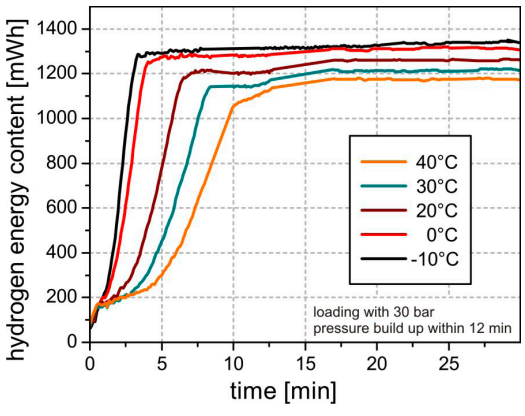


Fig. 2 Hydrogen loading of metal hydride compacts