Stage 7

Heat flux sensors - application areas in industry and IoT

greenTEG AG & Ineltro, 8th June 2017, Zürich

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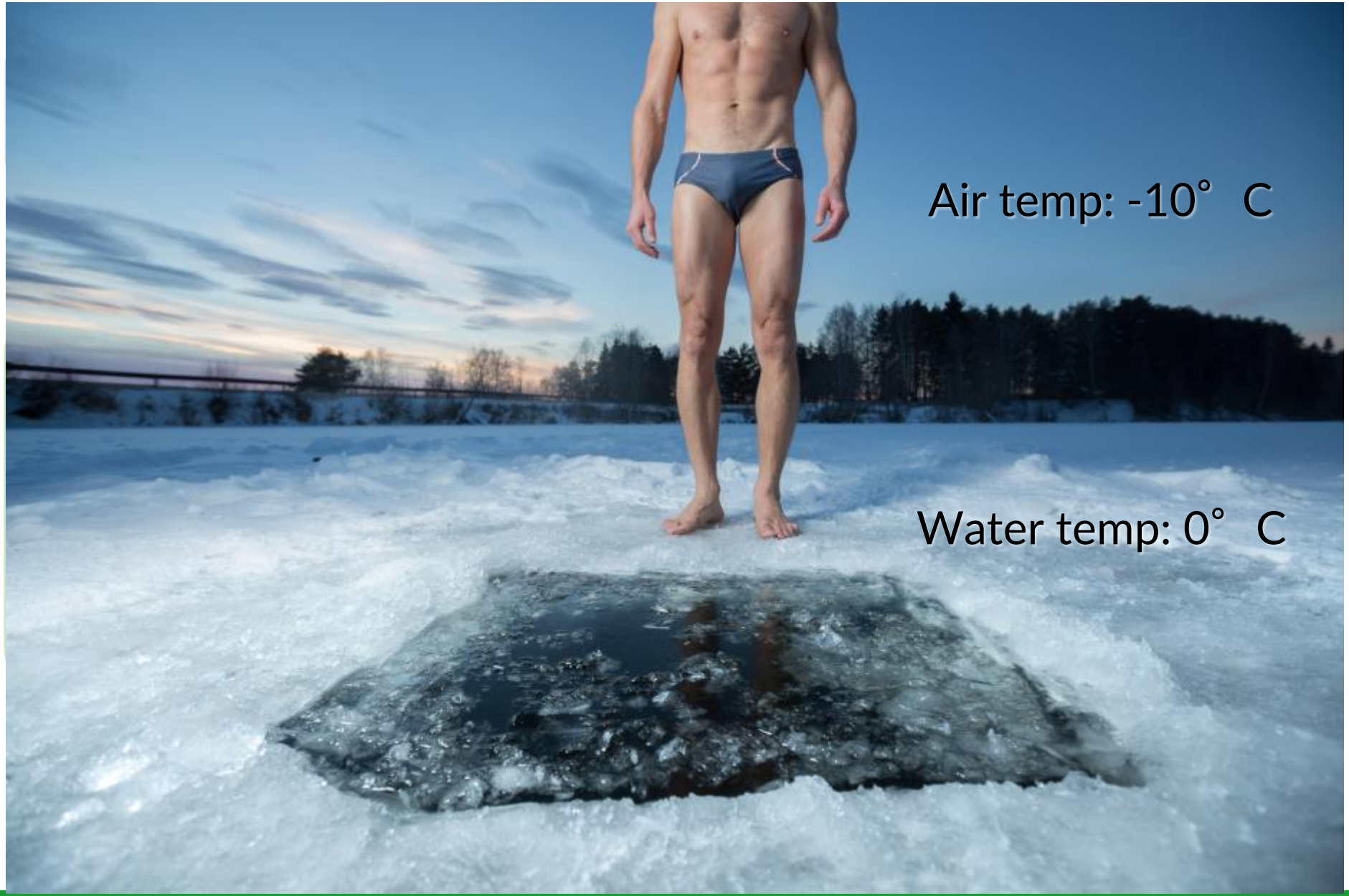
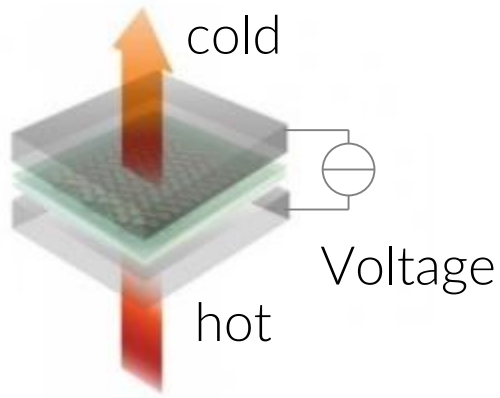
gSKIN®: Is our skin measuring temperature?



greenTEG – Efficiency Enabled

greenTEG fabricates thermoelectric sensors which convert heat into a voltage

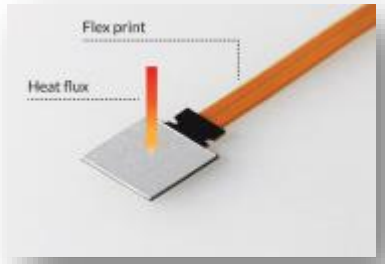
Heat flux sensor



Principle

Heat

Voltage



Device

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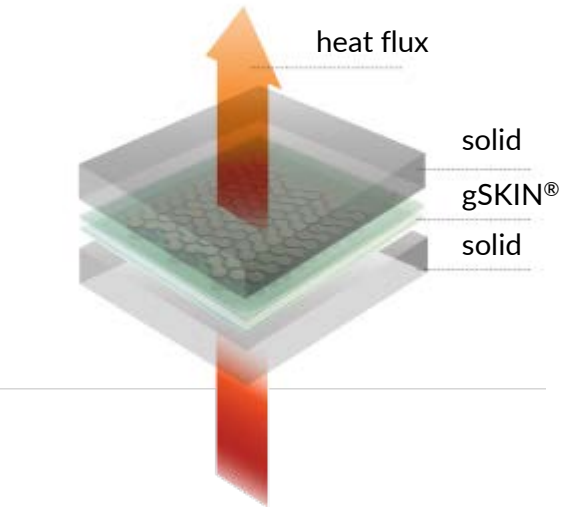
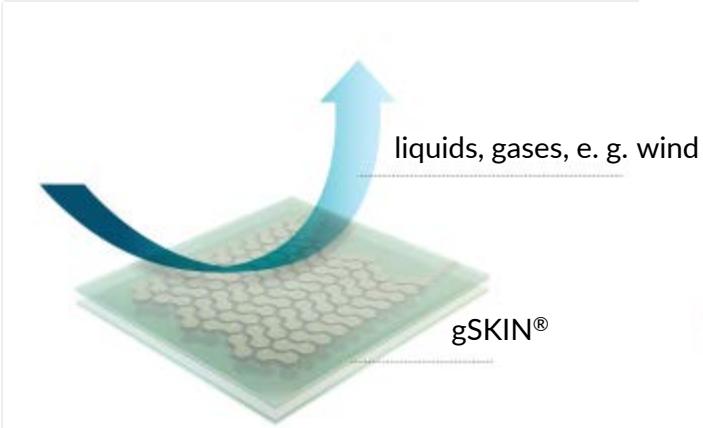
Three Types of Heat Flux



Conduction

Heat flux through materials

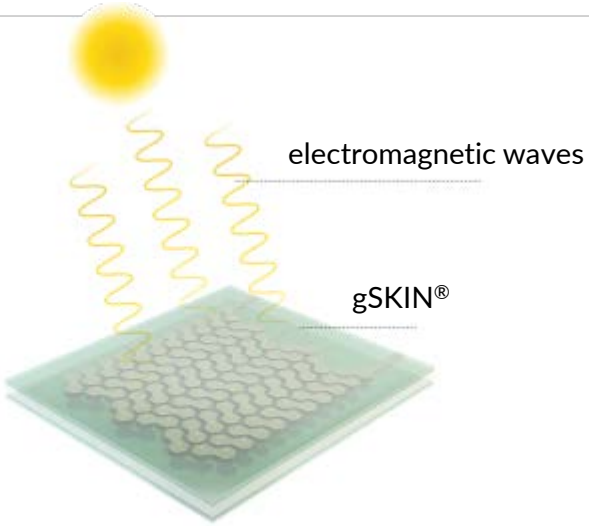
Sitting on a wood or stone bench in winter



Convection

Heat flux through liquids and gases

Exposure to wind chill



Radiation

Heat flux through electromagnetic waves

Standing next to fire

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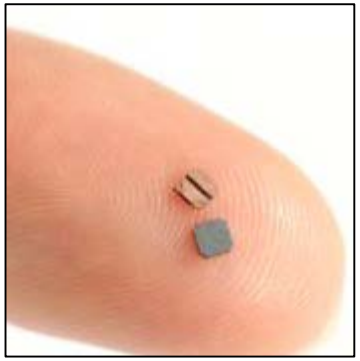
gSKIN® heatflux sensors

R&D

OEM



- Highly sensitive (resolves ΔT in µK)
- Thin (low invasiveness)
- Fast
- Highly robust
- Easy to integrate

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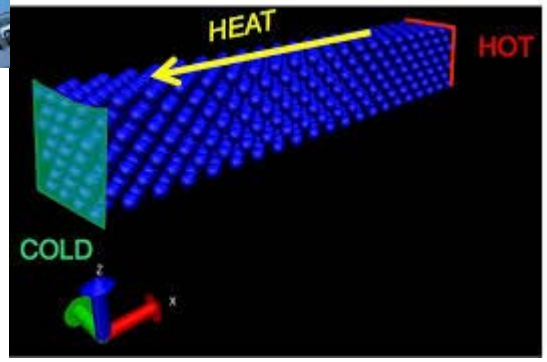
Overview of application areas



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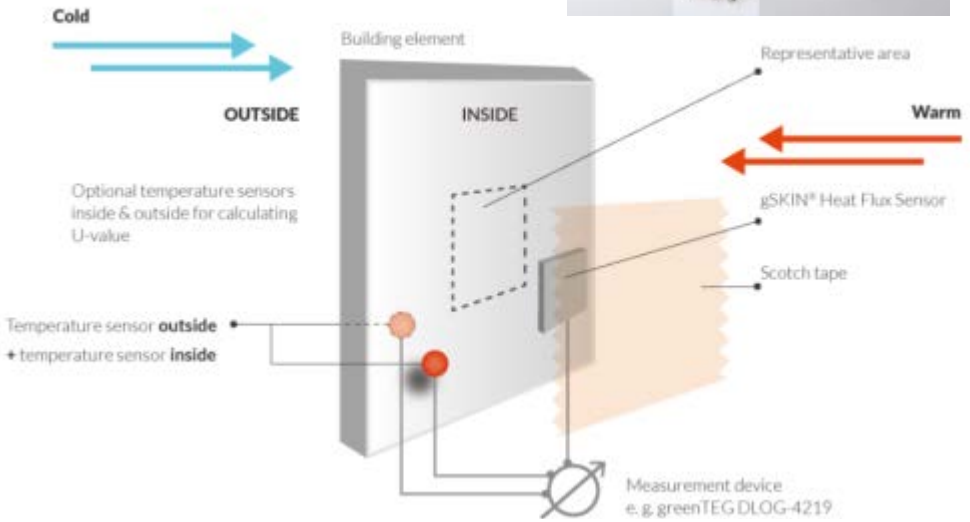
How good is your thermal insulation?

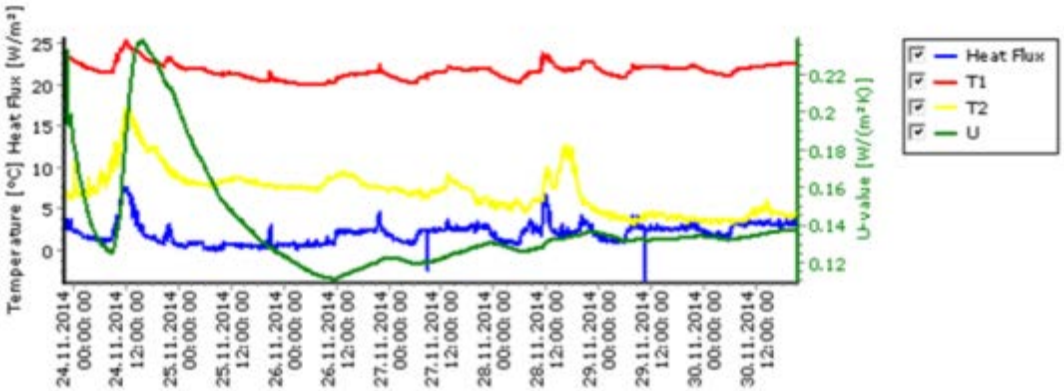
Measure the insulation property of

- Building envelope
- Industrial ovens
- Fridges & Cooling chambers
- Pipes



Principle

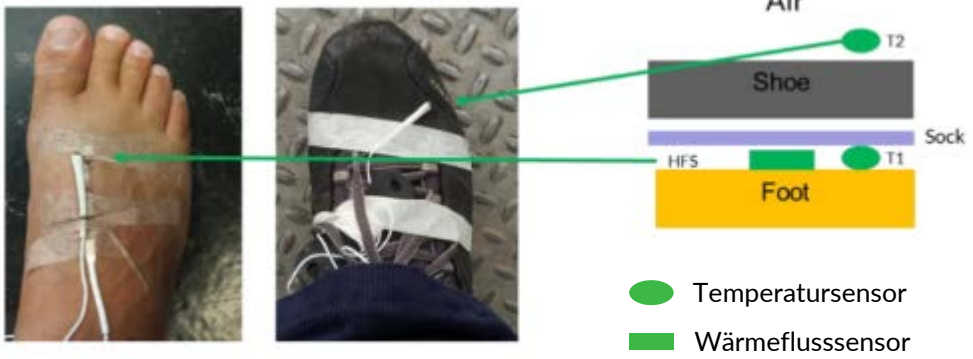
$K = (Q/T_{in}-T_{out})$

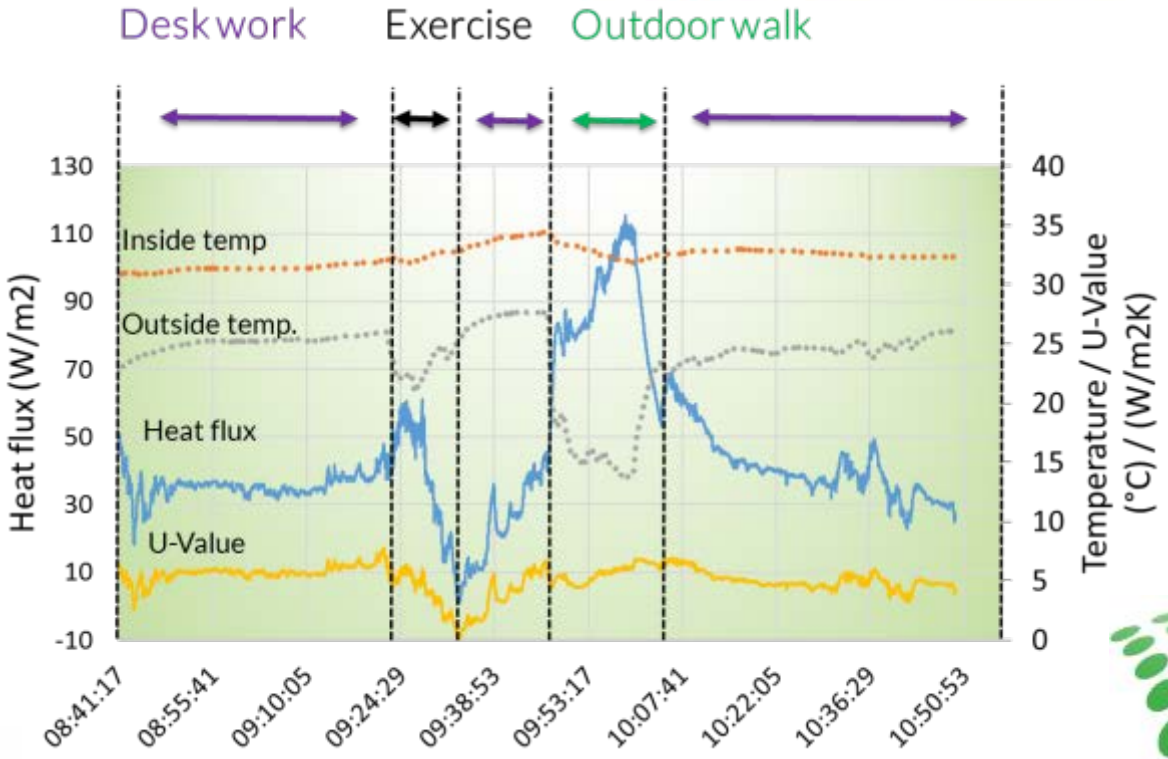


Sens what the body feels

Thermal characterization under real conditions of:

- Textile
- Footwear
- Car seats





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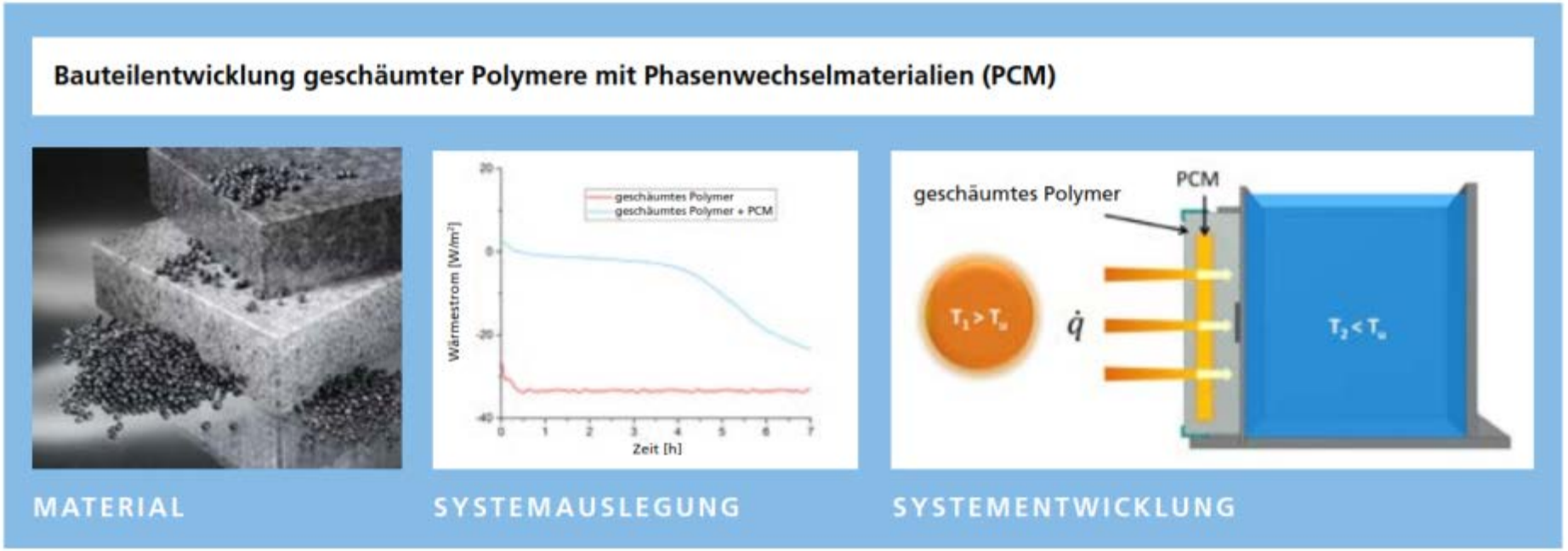
How much thermal energy is stored?

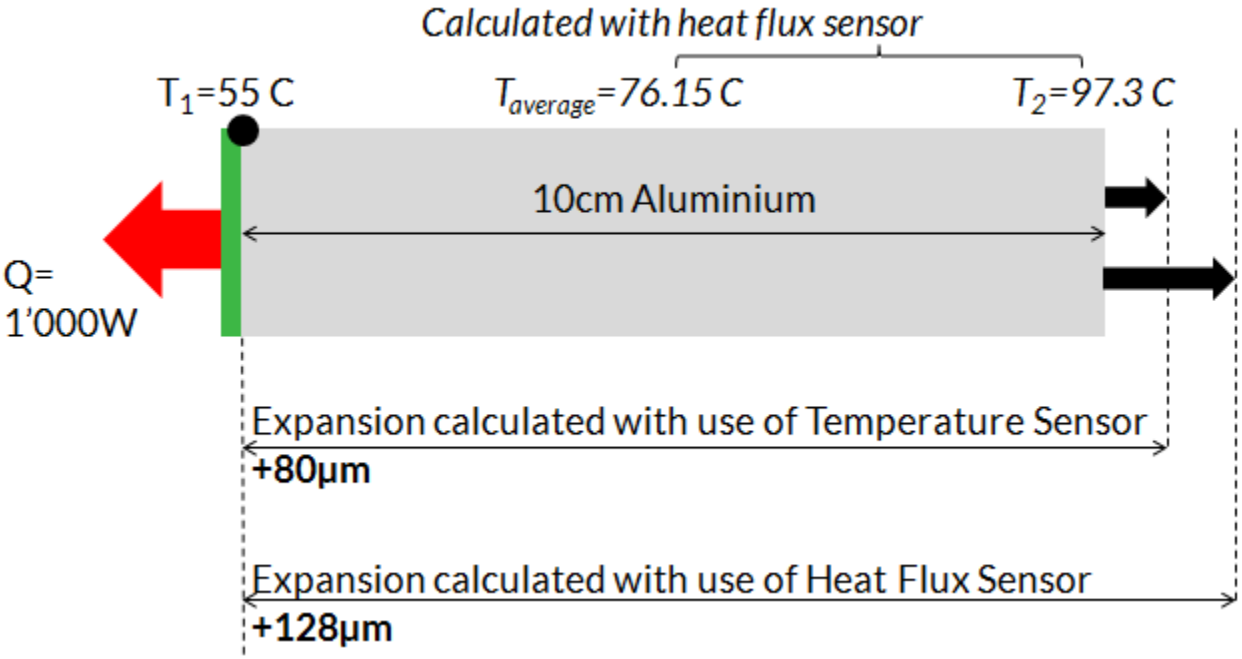
> Latent heat storage systems (status control of PCM)

- Problem: In the phase transition status, temperature is constant
- Solution: Energy measurements with HFS

Source: Fraunhofer ISC, Germany



Thermomechanical Compensation in Precision Instruments



Temperature Sensor

Heat Flux Sensor

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Fouling and Icing detection

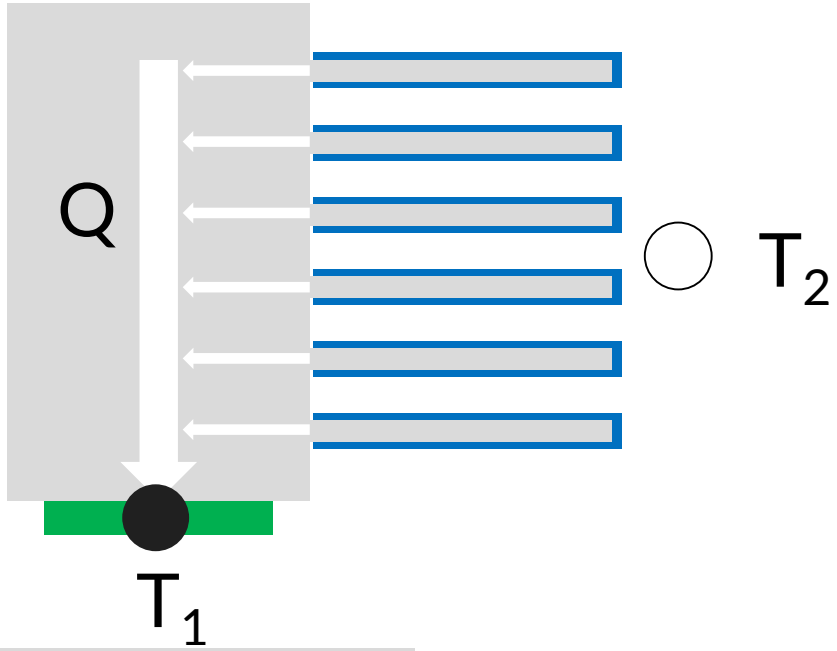
Controlling deicing of dommercial defrigeration units

Detecting algae covering on ship rump

Temperature Sensor

Heat Flux Sensor

Fan with fouling



Calculation method

- $R_{therm1-2}$ influenced by ice, rust etc.
- R can be calculated by T_1, T_2 and Q
- $R_{therm\ 1-2} = (T_2 - T_1)/Q$

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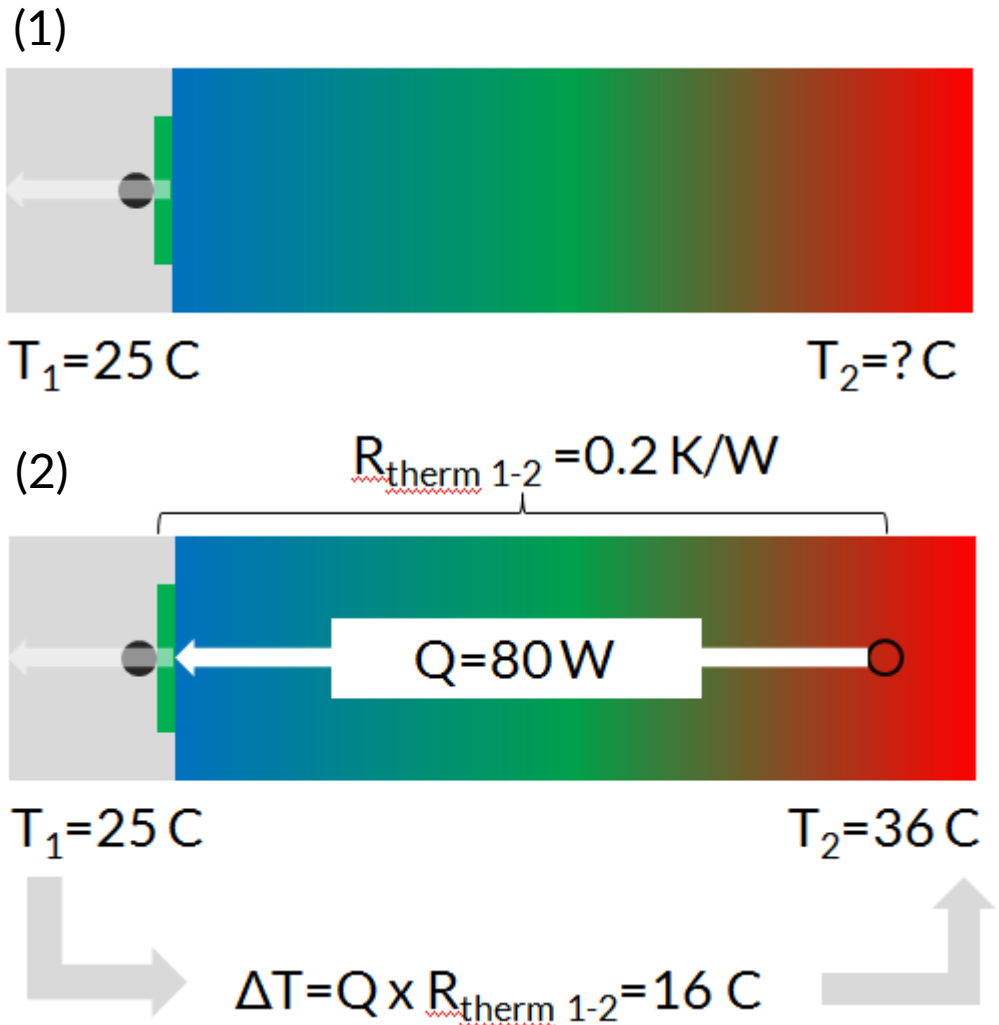
Sens the temperature inside a body

Indirect temperature measurement can find
e.g. its application in beer tanks



Temperature Sensor

Heat Flux Sensor

Non-invasive core-body temperature measurements

Core Body Temperature is one of the important vital parameters without a solution for being measured

Vital parameters

✓	✓	✓	✗	✗
Respiration	Oxygen saturation	Heart rate	**Core body temperature (CBT)**	Blood pressure

Key problems with current solutions:

- High invasiveness; Low accuracy; Difficult to integrate

Reasons for CBT measurement:

- Preventive health care; Early diagnosis
- Key areas:

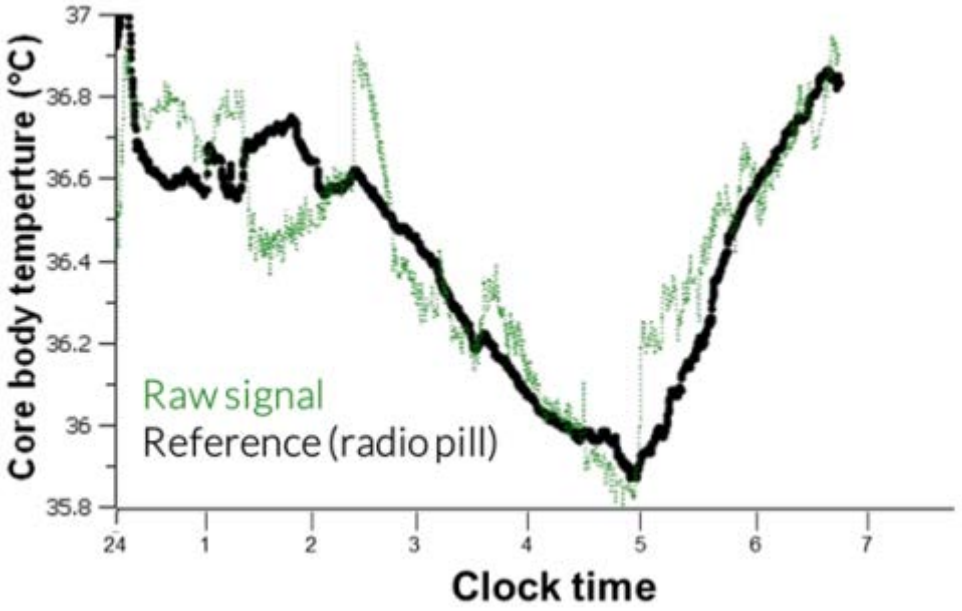
Ovulation

Insomnia and Narcolepsy

Stress

Alzheimer

greenTEG offers the first ever non-invasive measurement of the Circadian cycle



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Battery calorimetry

Battery Calorimetry with gSKIN sensors enables:

- Determination of battery quality
- Life time and aging investigations
- Electrode disbalancing corrections
- Real time control of battery inner temperature

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Detect the quality of a battery

- The reformation during charging and discharging of the Li at the electrodes results in an entropic heat release or uptake

- Shape and position of the transition peaks recorded with heat flux sensors gives information's about:
  - Quality of the battery
  - Aging of the battery
  - Real charging stat of the battery

- Helps to prevent:
  - Thermal runaway
  - Electrode disbalancing
  - Fast aging of the battery

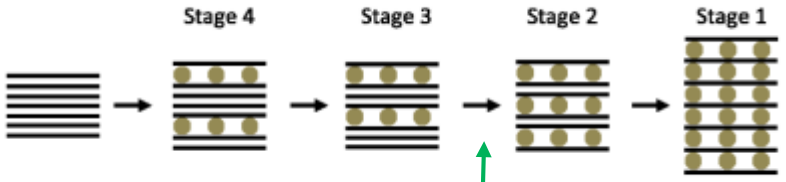
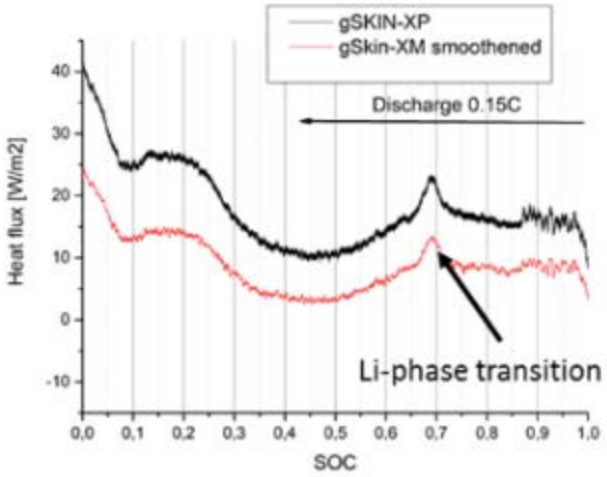


Figure1 : Model of ion intercalation into graphite by Rüdorff [1]



Position and shape of the Li-ion phase transitions peaks determines the health status of the electrodes and dangerous shifts in its real potentials

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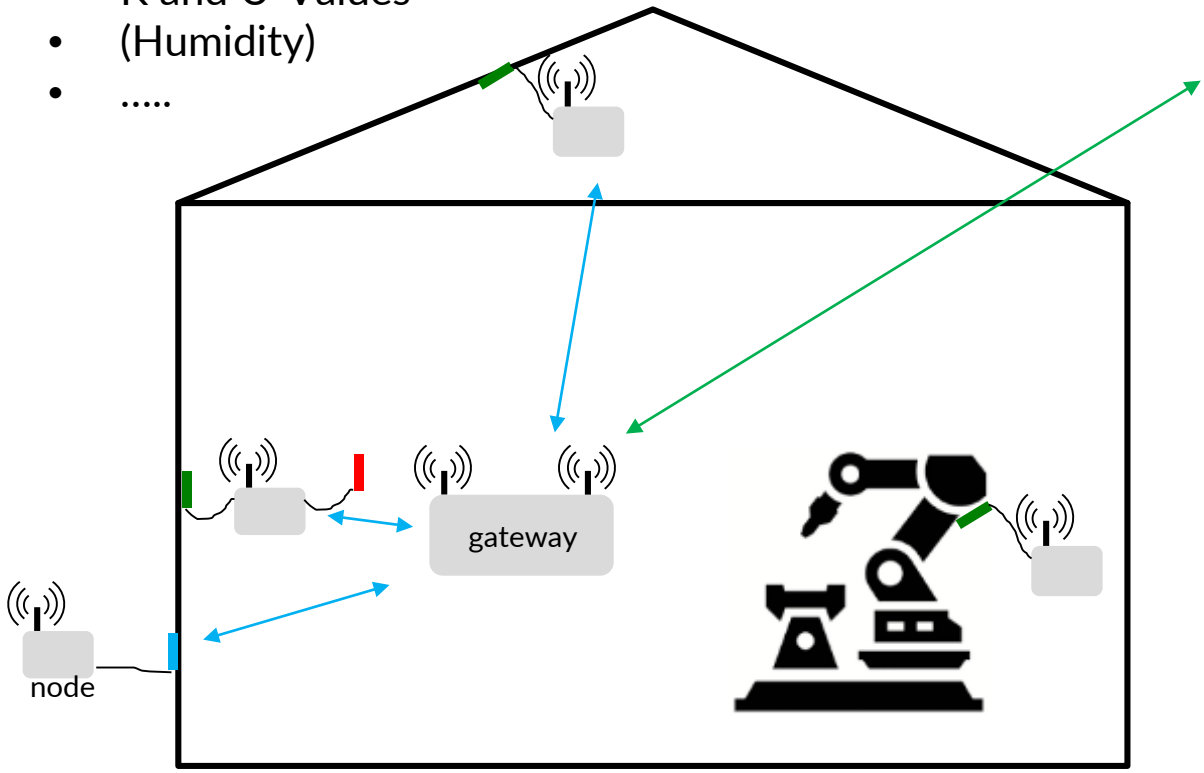
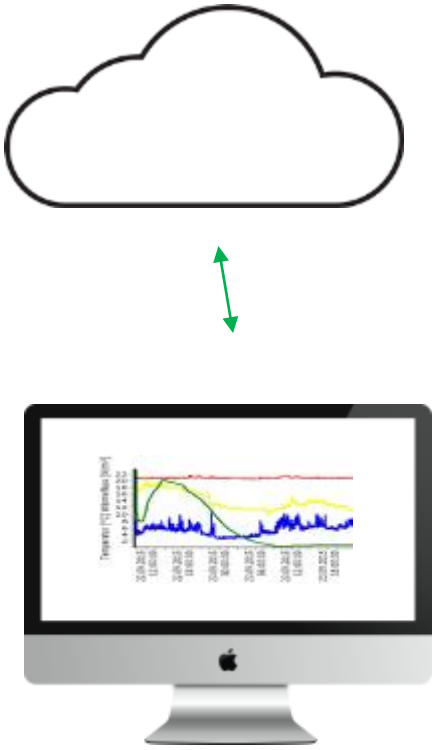
Heatflux sensors soon also wireless

- Wireless sensor nodes
- Central gateway to upload data into the Cloud
  - Heat flux
  - Ambient temperature (with low α)
  - Surface temperature
  - K and U-Values
  - (Humidity)
  - .....





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Conclusions

- Temperature is an important parameter
- However, to understand more abut the **dynamic effects** in **thermal system** a combination of the temperature sensor with a **heat flux** sensor is the right solution

Thank you for your attention

Do you see any applications in your area?

Please visit us at our booth.

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