Humidity
Theoretical and practical aspects

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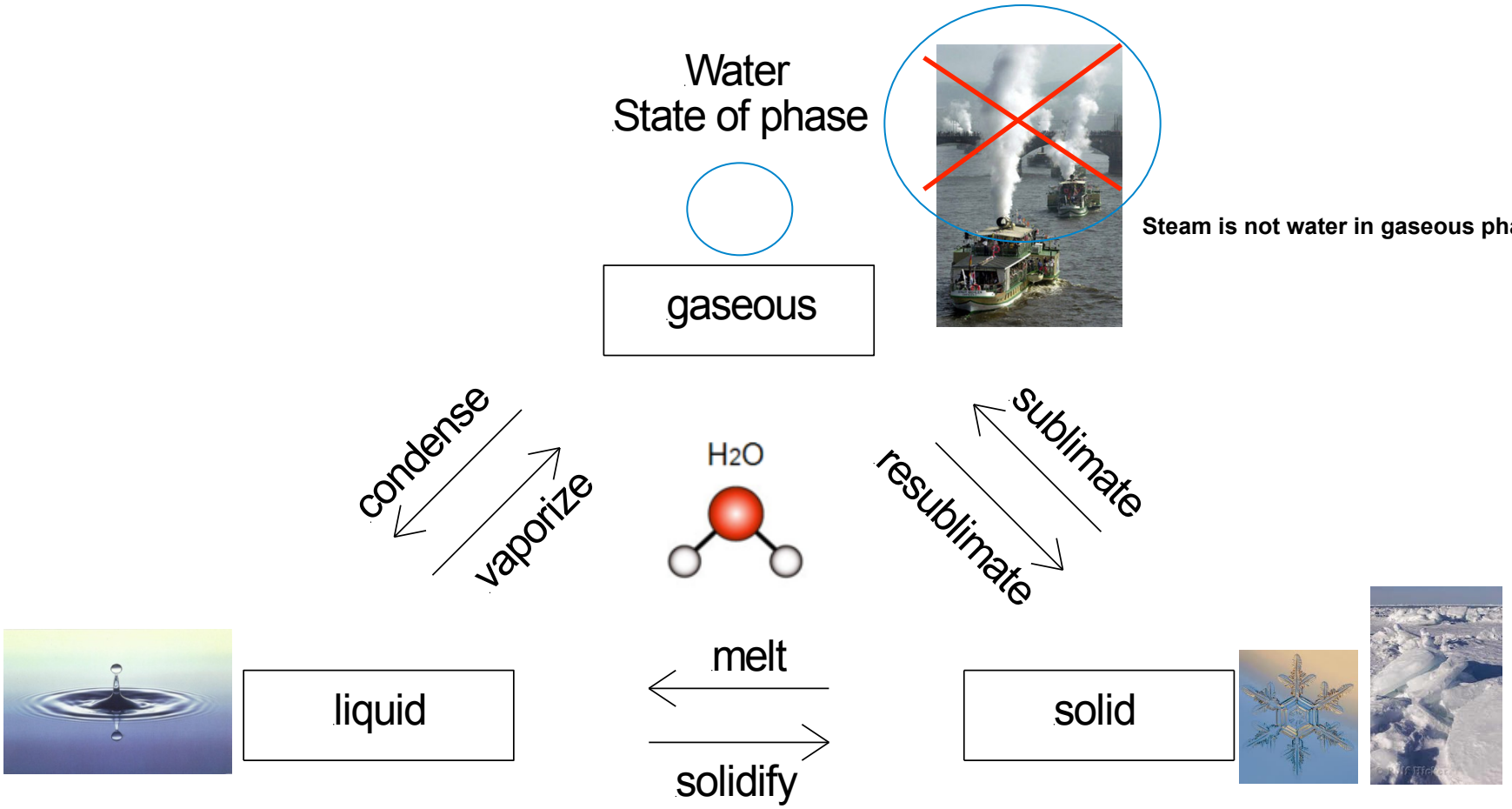
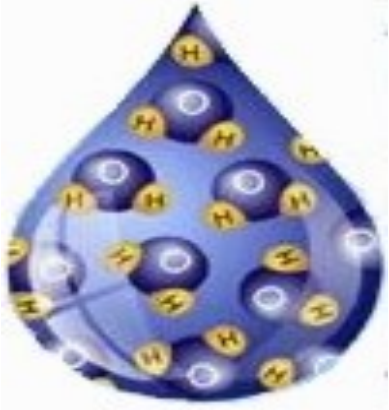
Fascination water



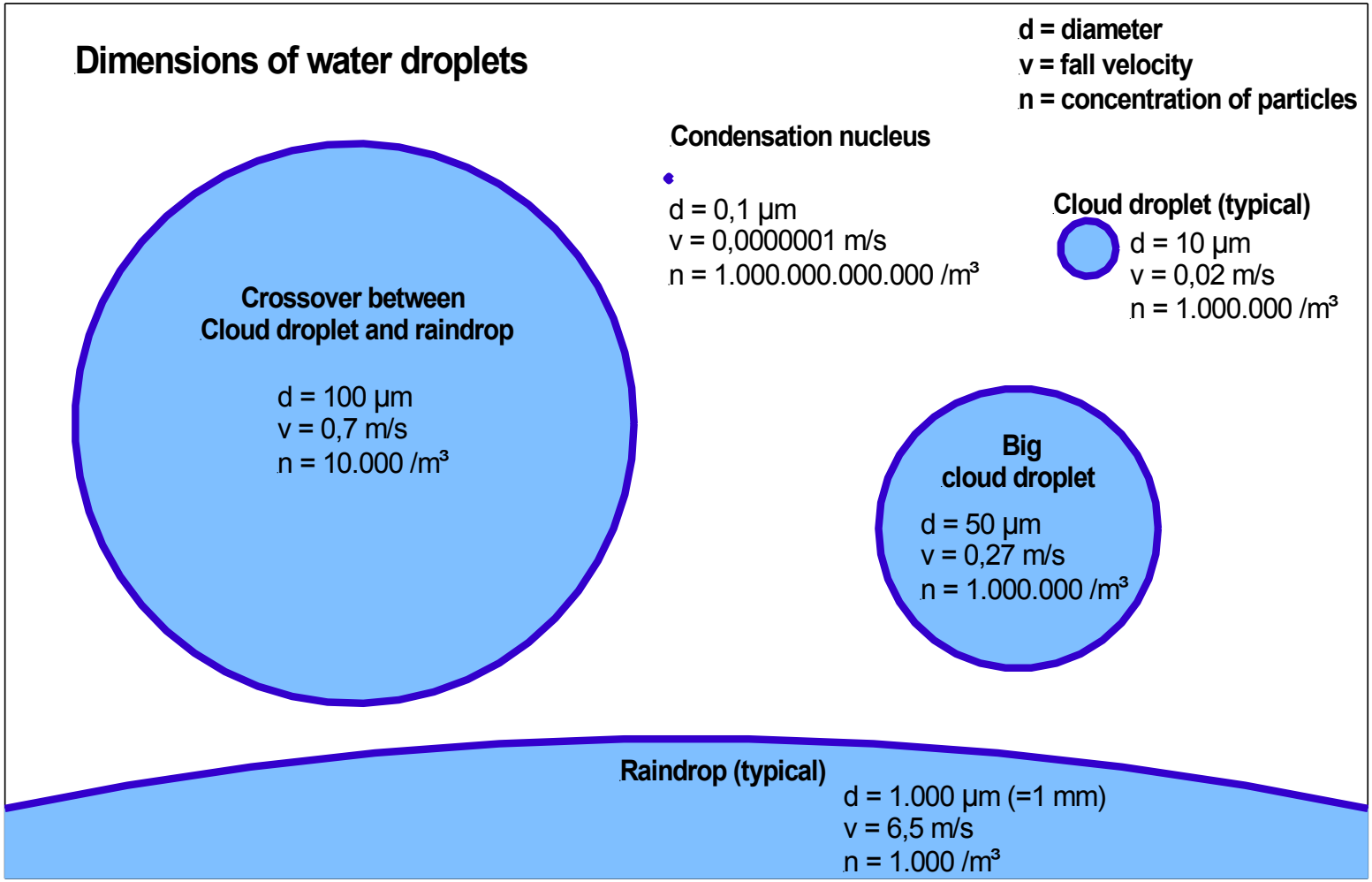
Fascination Water

Water molecule size ≈ 0,0001 micron



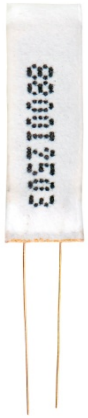
small, barely visible droplet ≈ 1 to 40 micron

Fascination Water



Measuring principles

Our measurement devices and sensors are measuring water in gaseous phase



Not water-level

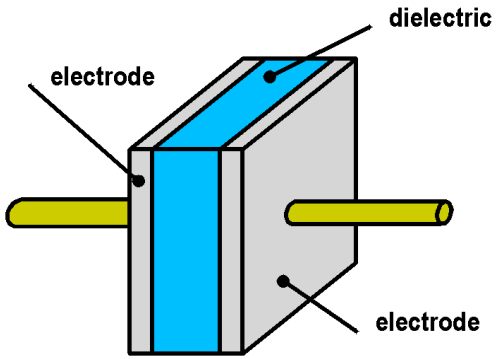
Not droplet size

Not fog density

Not moisture content

Principal aspects

capacitor



$$C = \varepsilon_0 \varepsilon_r \cdot \frac{A}{d}$$

Relative permitivity for some materials at 18 °C and 50 Hz

vacuum	ε_r = 1,0
air	ε_r = 1,00059
water	ε_r = 80,1
Polypropylen	ε_r = 2,1
Plastics	ε_r = 2…4

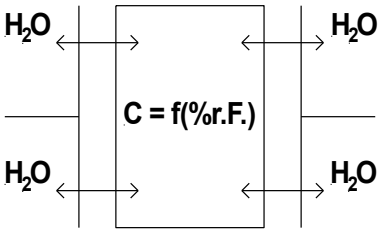
In case of a humidity sensor:

$\varepsilon_r = \varepsilon_{r\ Polymer} + \varepsilon_{r\ H2O}$

C = **f(%RH)**

The signal change of the sensor is effected by the change in concentration of water molecules within the polymer lattice structure of the used dielectric.

Ralative permitivity of water



Temp. (°C)	$\varepsilon_{r\ (water)}$
0	87,69
10	83,82
20	80,08
30	76,94
40	73,02
50	69,70
60	66,51
70	63,45
80	60,54
90	57,77
100	55,15

$$C = \varepsilon_0 \varepsilon_r \cdot \frac{A}{d}$$

- When water vapor is the main component of the determined ε_r-value, you can see from the Tables, the dielectric constant of water is strictly speaking not a constant but a substance-specific base value which is temperature dependent.
- This results in a direct line to a temperature dependence typical of the entire humidity sensor characteristic.

How it works:

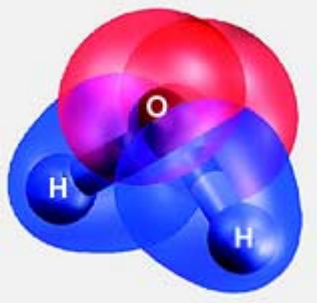
Capacitive humidity sensors are capable of detecting water in its vapor phase.
In a broader sense, gas sensors that are highly sensitive to H_2O.

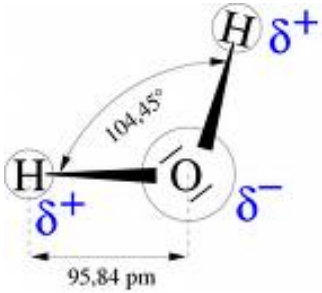
This is done by the storing of water vapor molecules in the polymer layer.

The high dielectric constant of water (ε_r = 80,5),

compared to that of plastics (ε_r = 2 ... 4),

corresponds with a high capacitve signal.

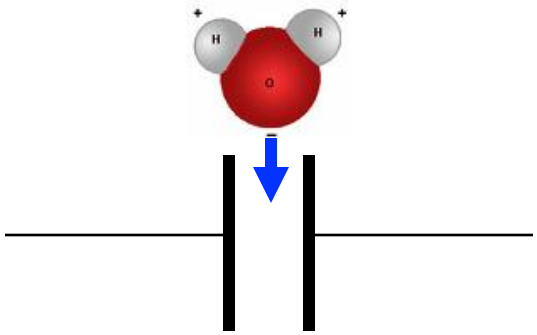




How it works:

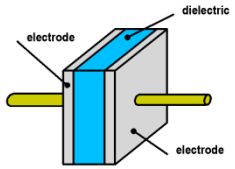
The water vapor exchange between the polymer and ambient air is only done by an existing diffusion gradient.

Only in the case that this gap is equal to zero, the capacity is in correspondence to the water vapor pressure of the ambient air.

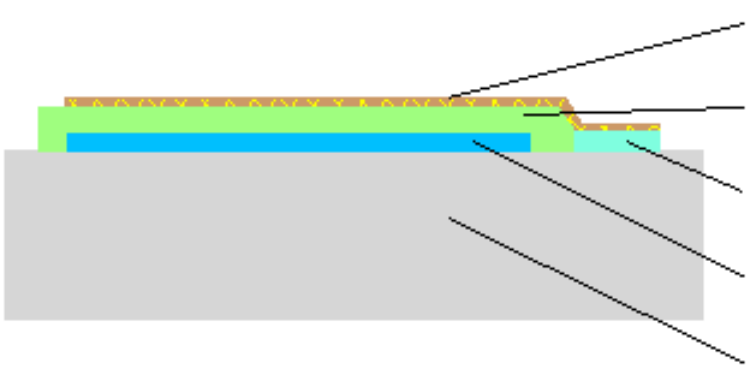


$$C = \frac{\varepsilon_r \times S}{d}$$

Sensor Technologies



Thin film sensor (schematic construction)



Cover electrode

Polymer (hygroscopic dielectric)

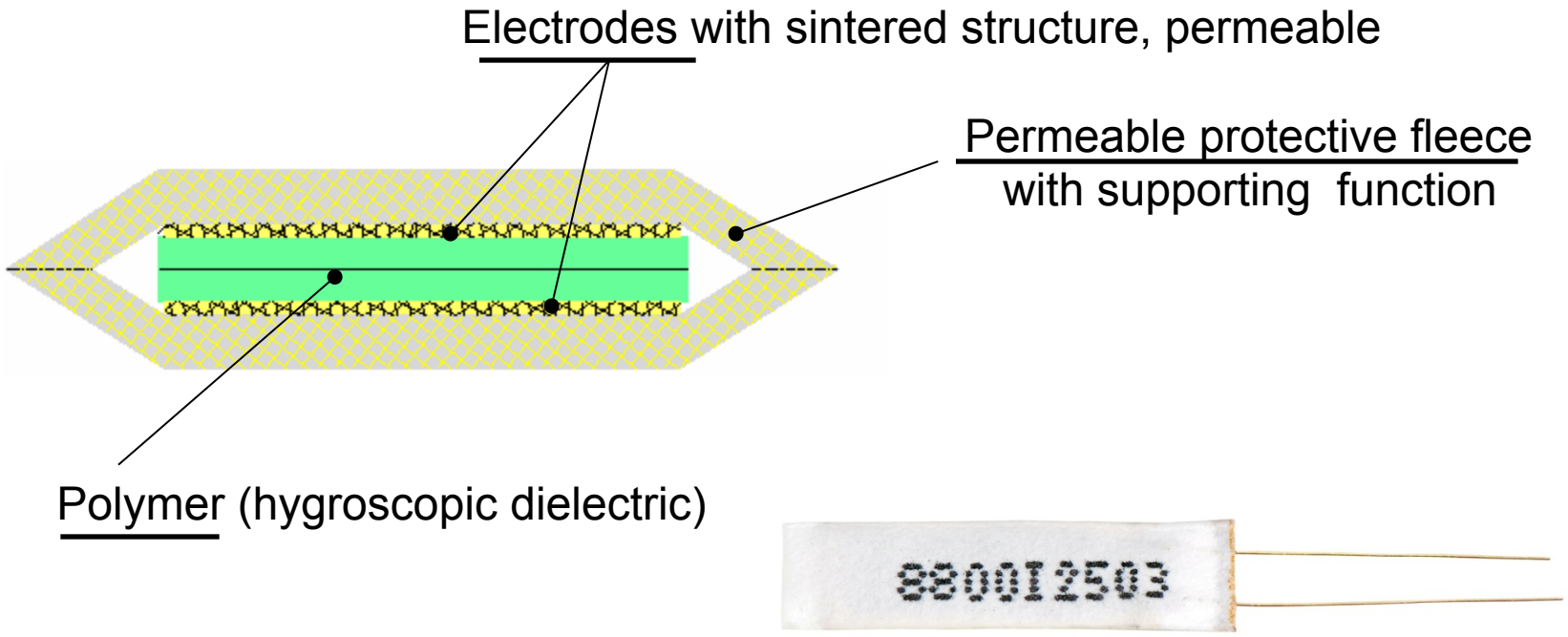
Connector pad for cover electrode

Base electrode

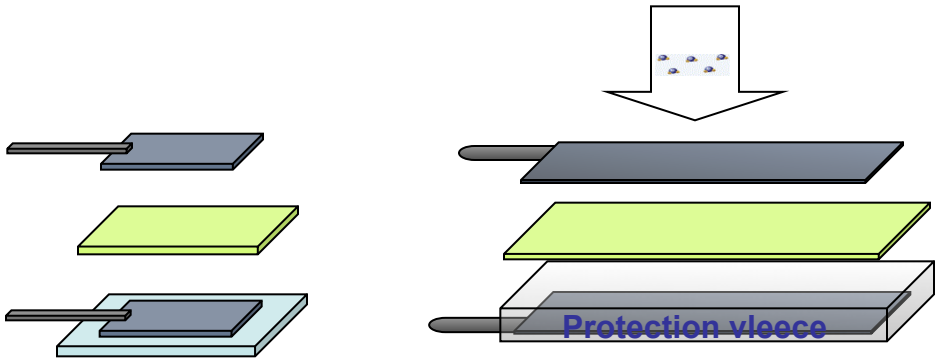
Substrate (ceramic or glass)

Sensor Technologies

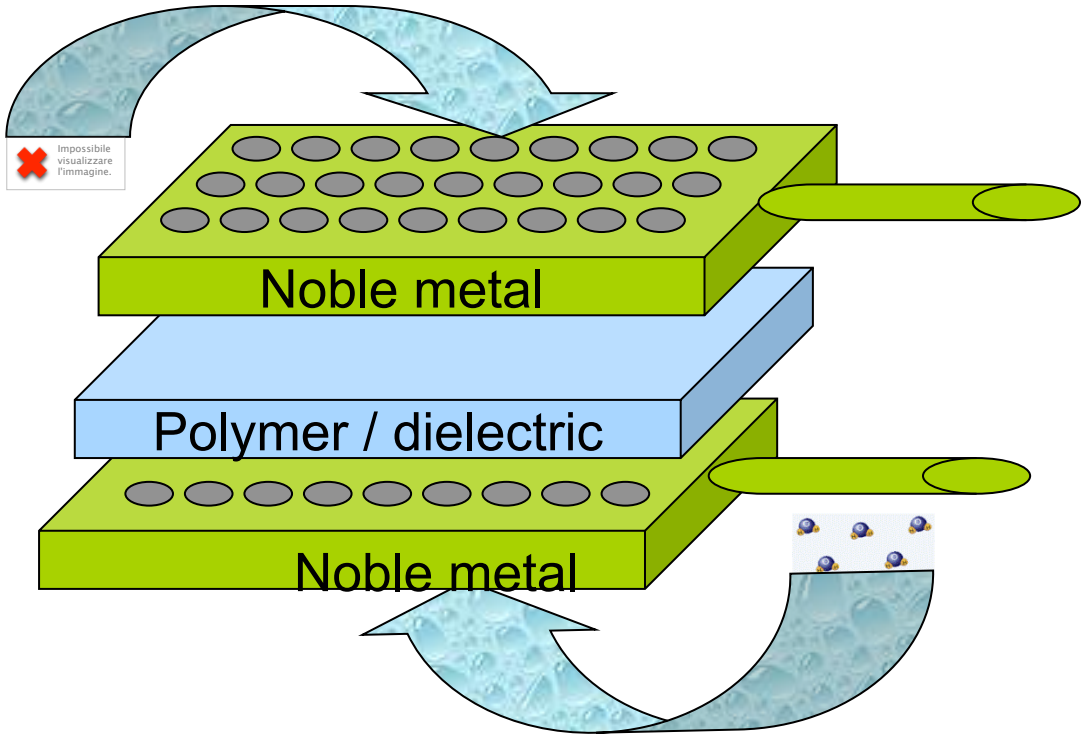
Thick film or foil sensor: (schematic construction)



Layer composition



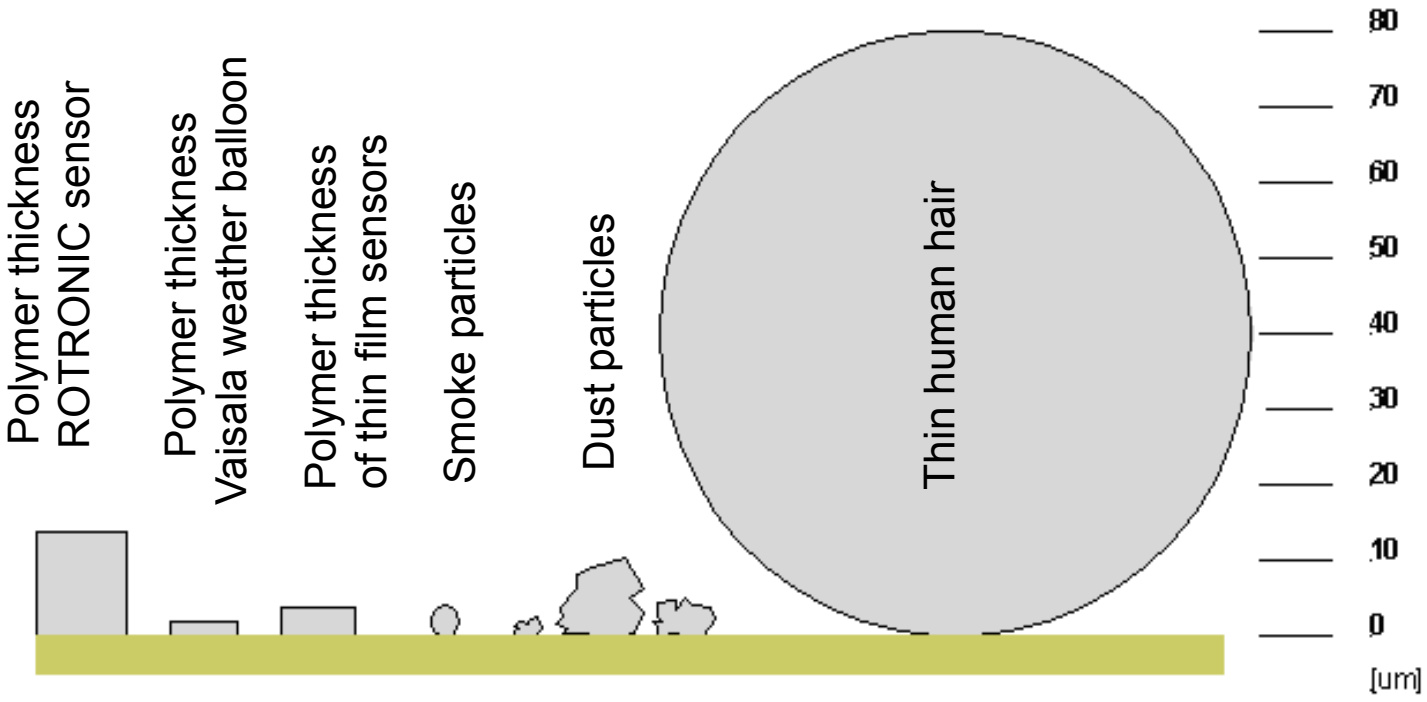
How it works:



Electrodes with double function:

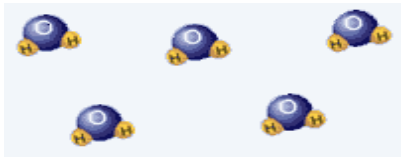
- **electrode acts as an electrically conductive plate**
- **Plate also permeable to water molecules**

Sensor Technologies

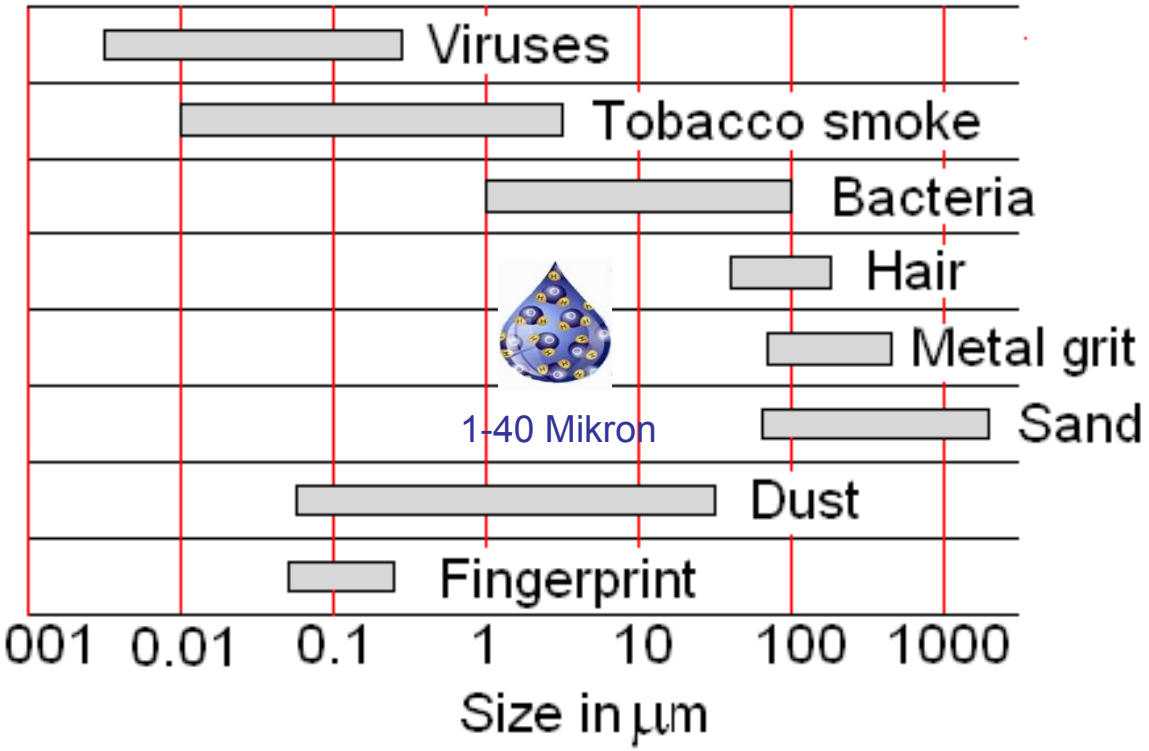


Sensor Technologies

Size correlations: **Water vapour molecule**



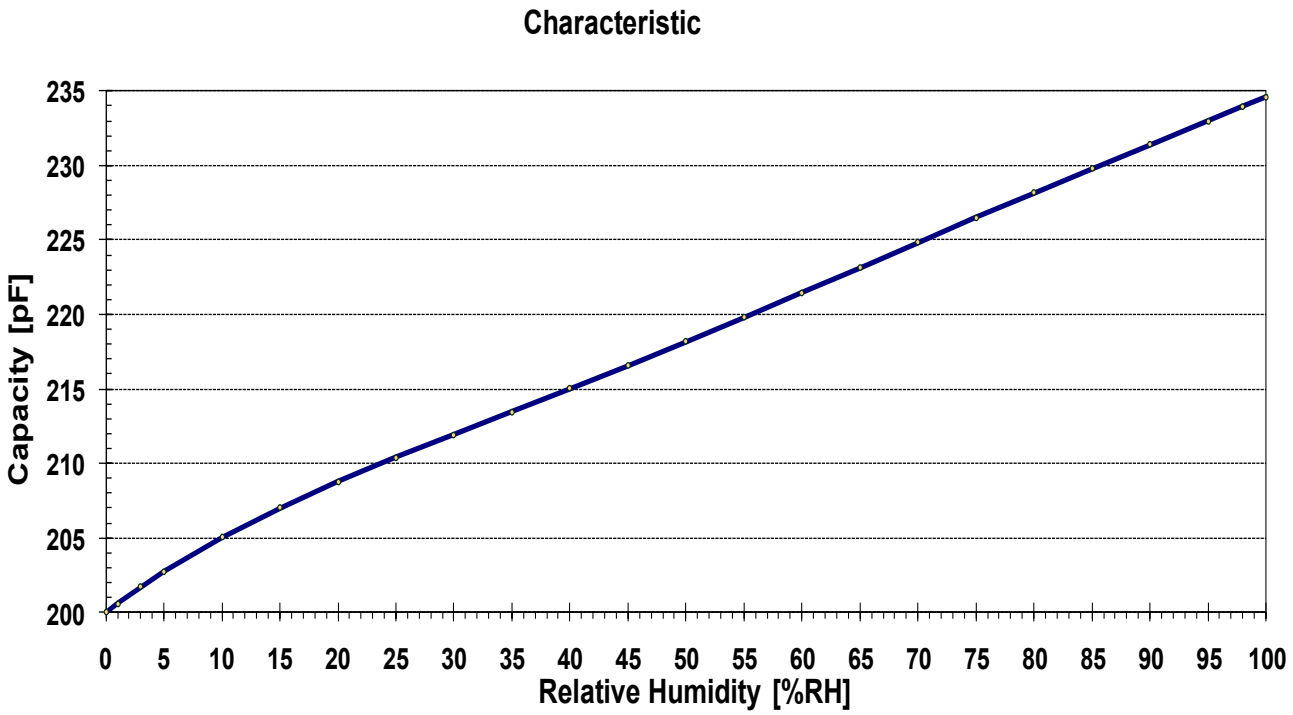
0.0001 Mikron



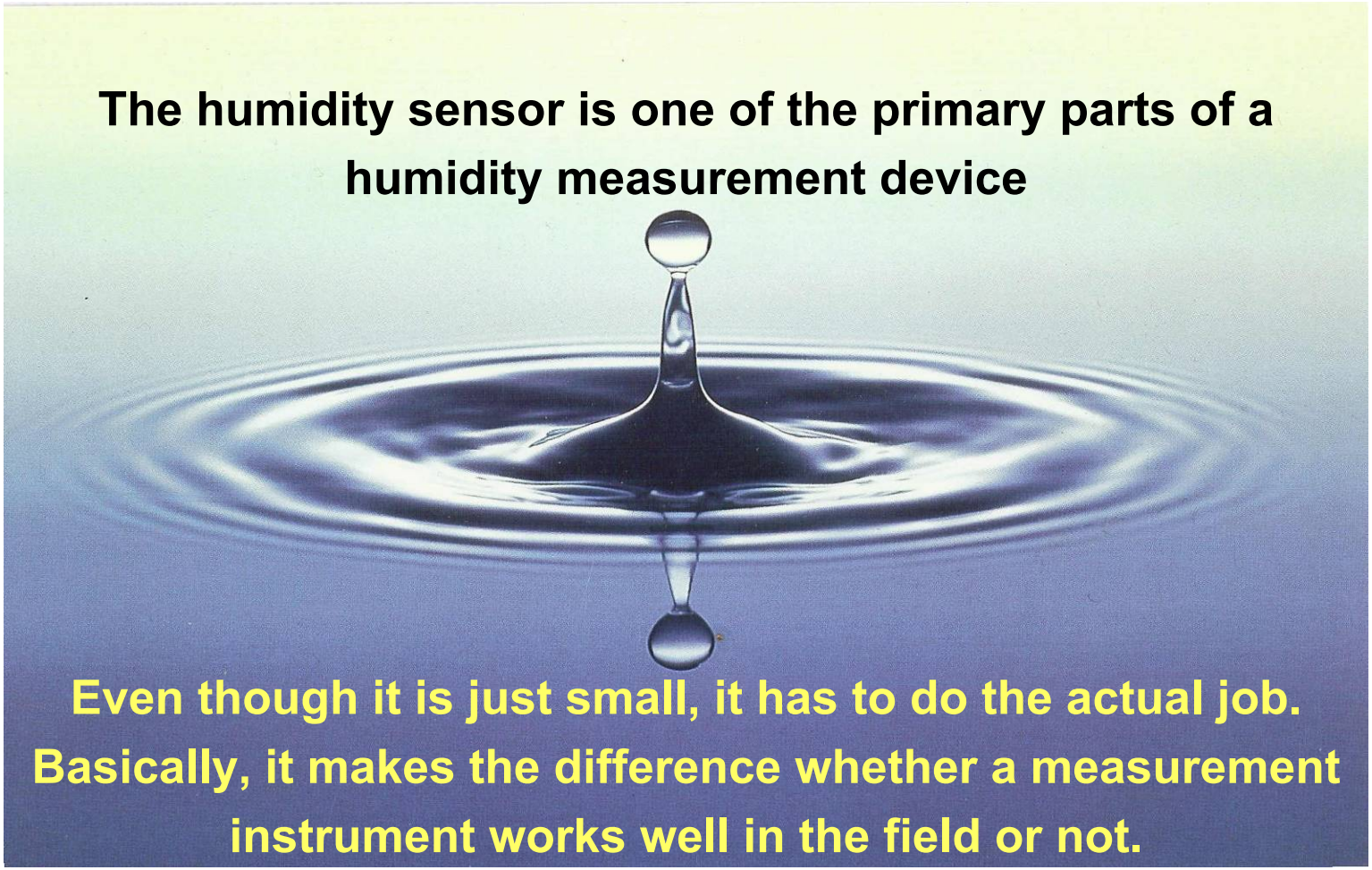
1-40 Mikron

How it works:


88001503


Characteristic
Capacity [pF]
235
230
225
220
215
210
205
200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Relative Humidity [%RH]

Measurement with
polymer based capacitive Humidity sensors



Sensor and Application

Even the best sensor cannot measure correctly, when built in an non-suitable protective filter or in a non-qualified probe construction, and thus cause measurement failures.

Correct measurement is depending on the interaction of

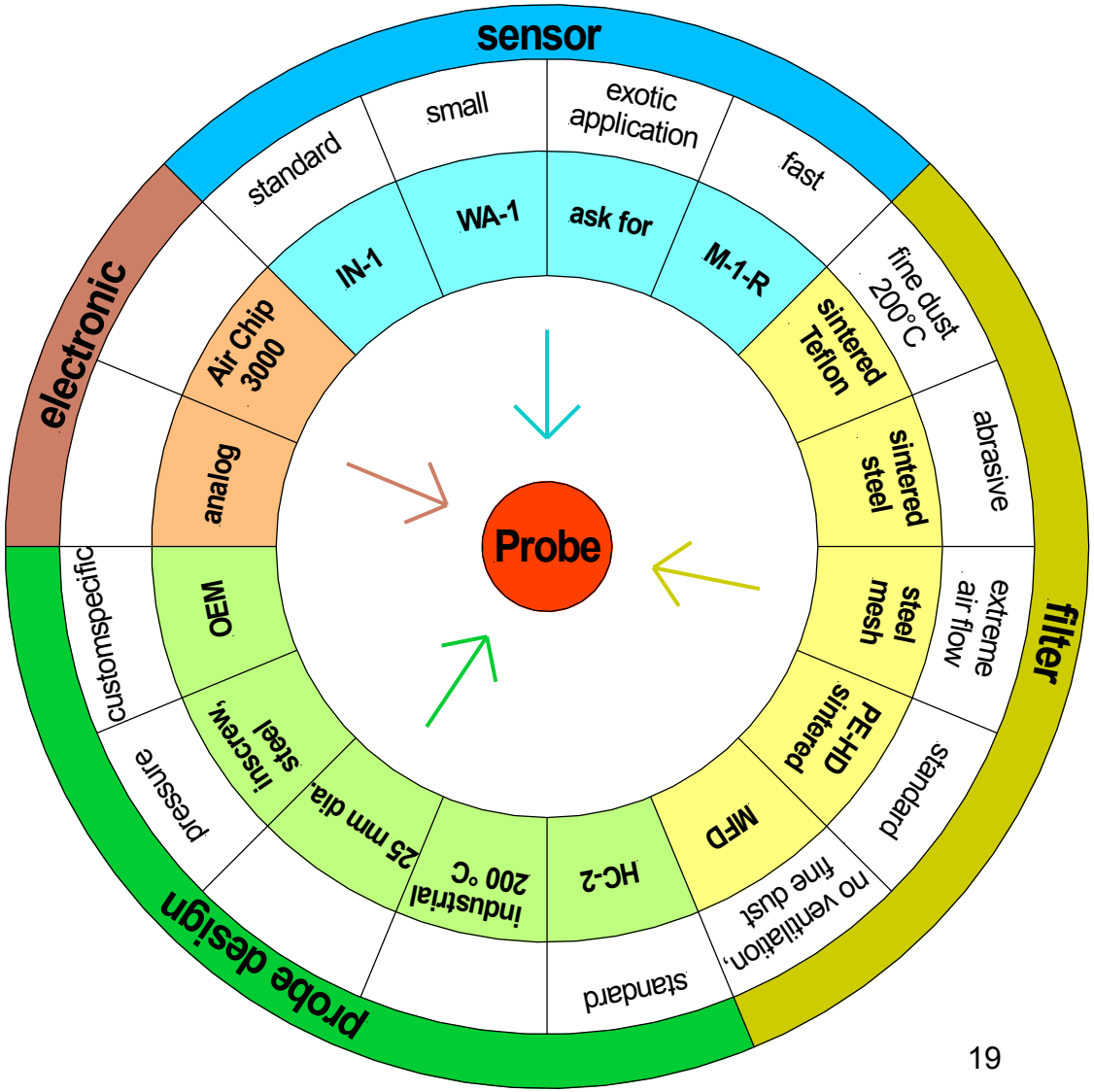
-> sensor

-> protection cage

-> construction of the probe

-> electronics

Basic combinations



Even if everything seems to be perfect, still keep an eye on the application.

A probe which may be perfect for use in non-ventilated radiation shields cannot automatically be used in similar applications like ventilated radiation shields, cheese cellars or for controlling the sterilisation of medical equipment.

Sometimes, even normally non-recommended sensors used in well constructed probes and placed at ideal installation points achieve better results than good sensors with standard probes located in non-qualified places.

Definition

Relative Humidity (%RH)

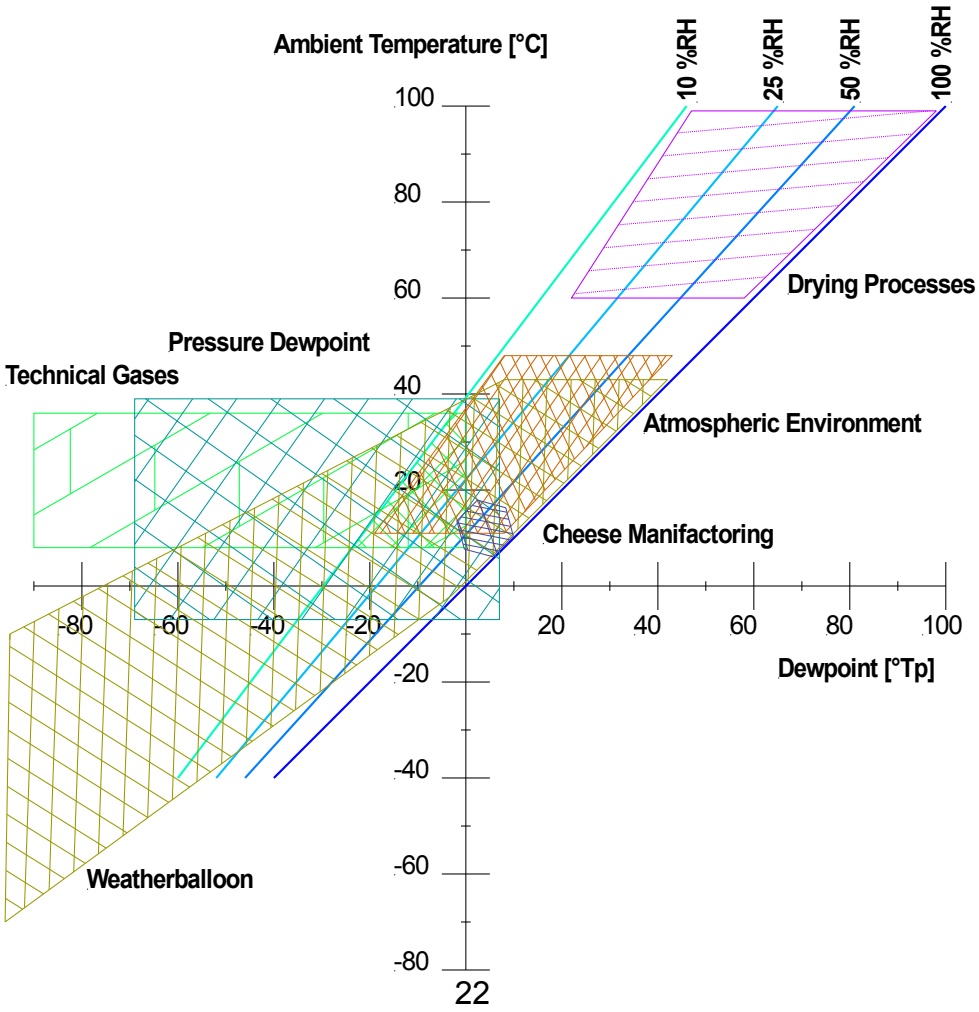
Is defined as the present ratio of water vapor in the air

to

the maximum possible water vapor at the same temperature / pressure.

$$\text{Relative humidity} = \frac{actual\ water\ vapor\ pressure\ in\ air}{saturation\ vapor\ pressure} \times 100\ \%$$

Area of application



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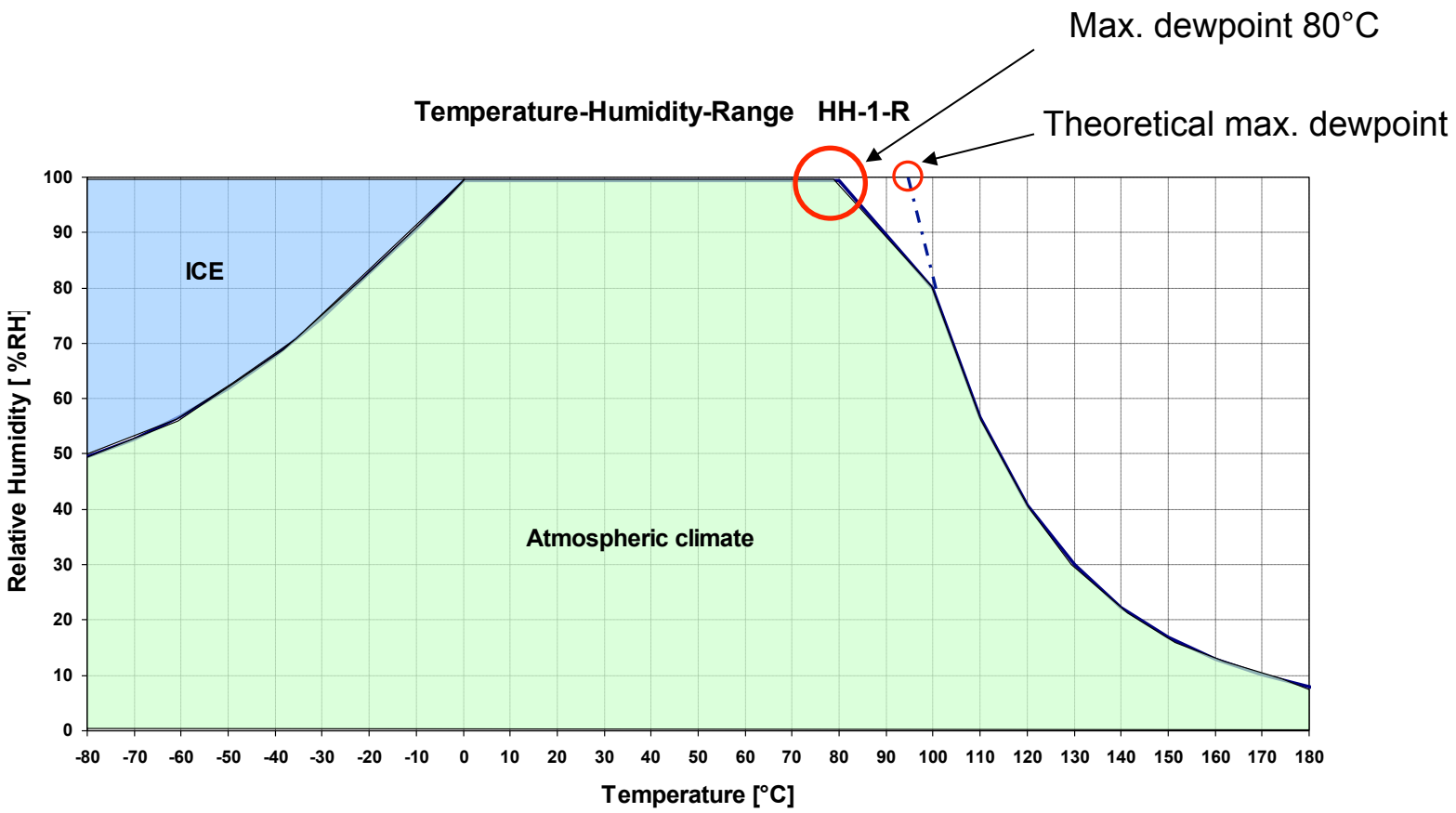
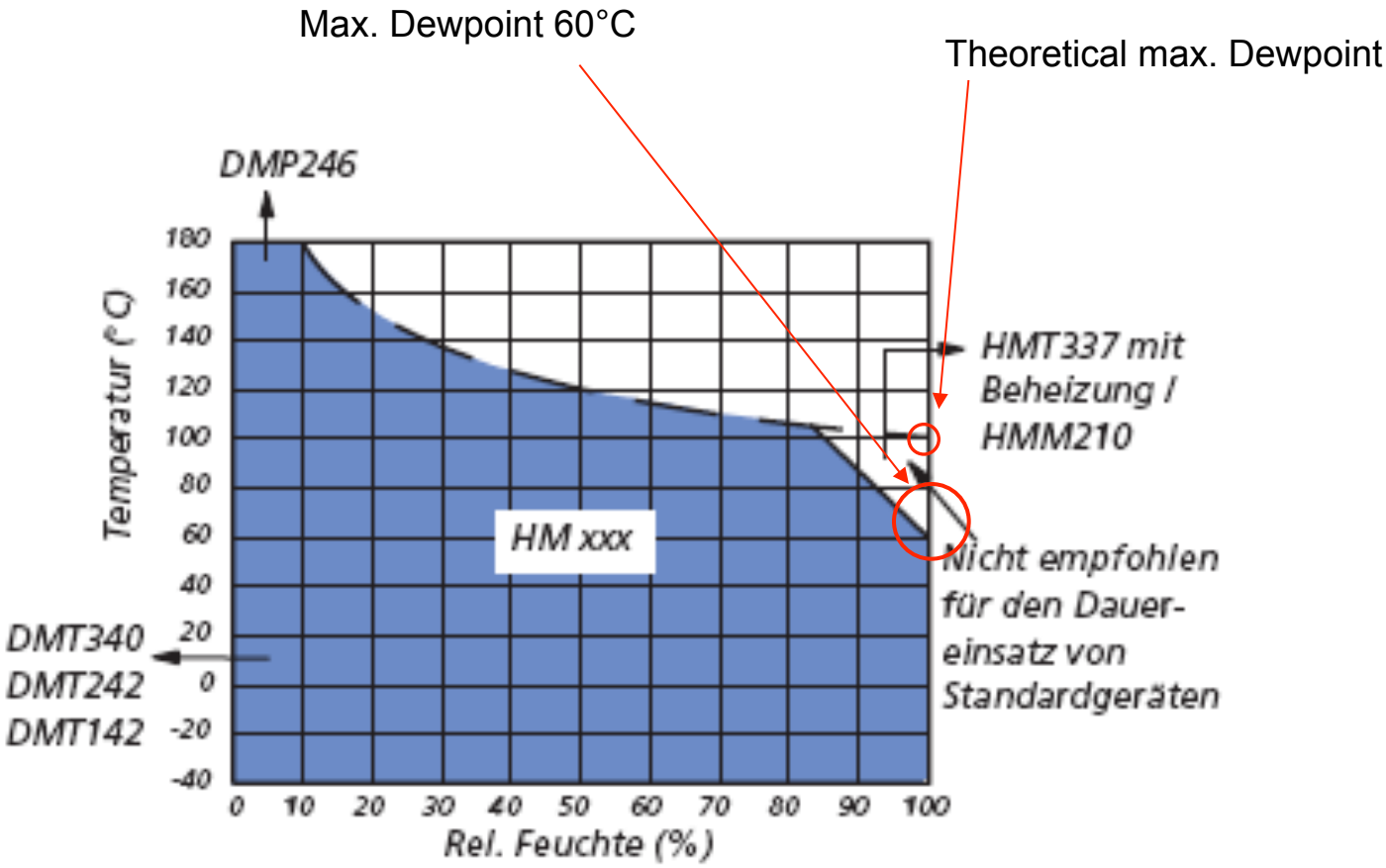
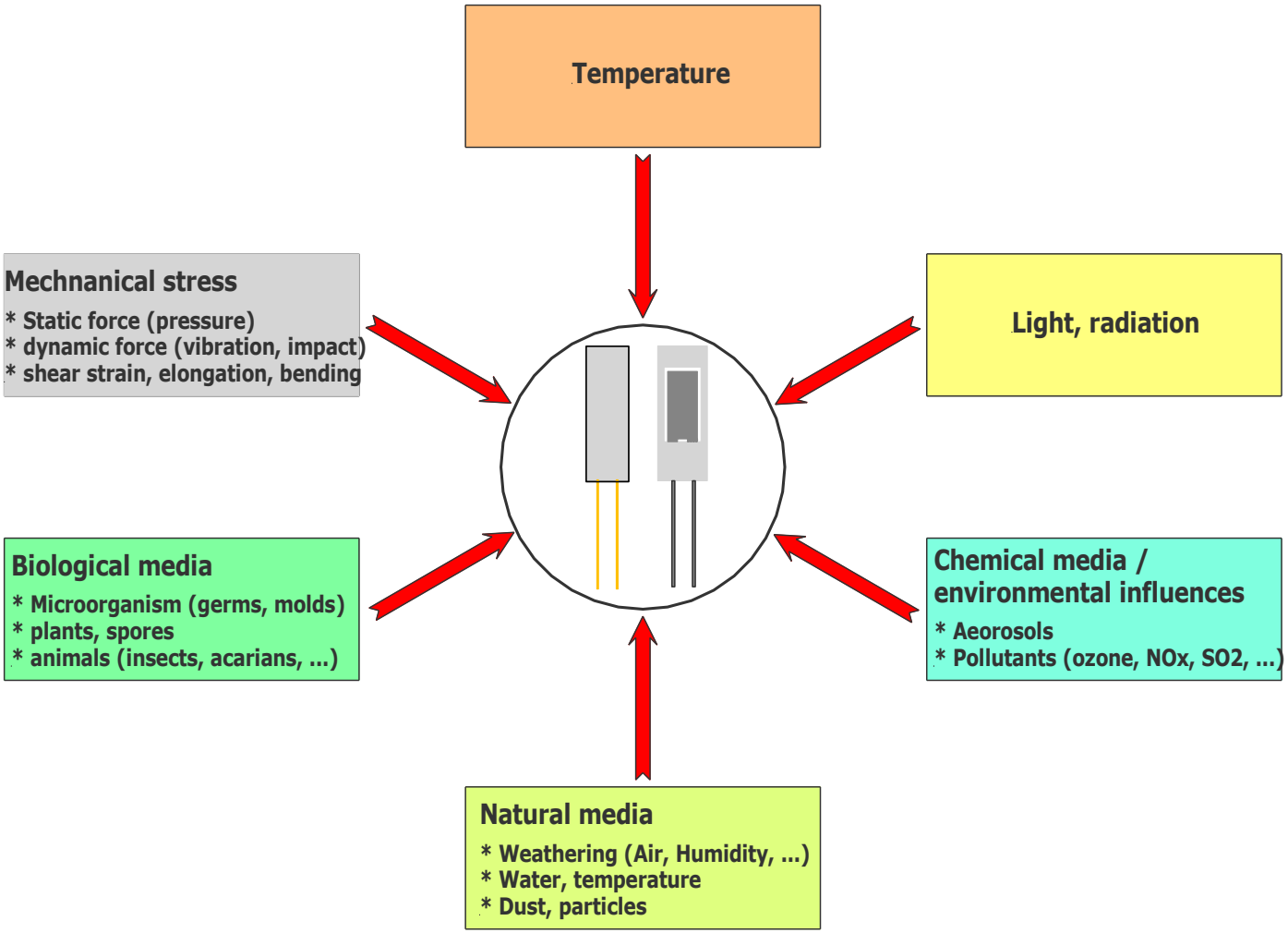
How to read technical data



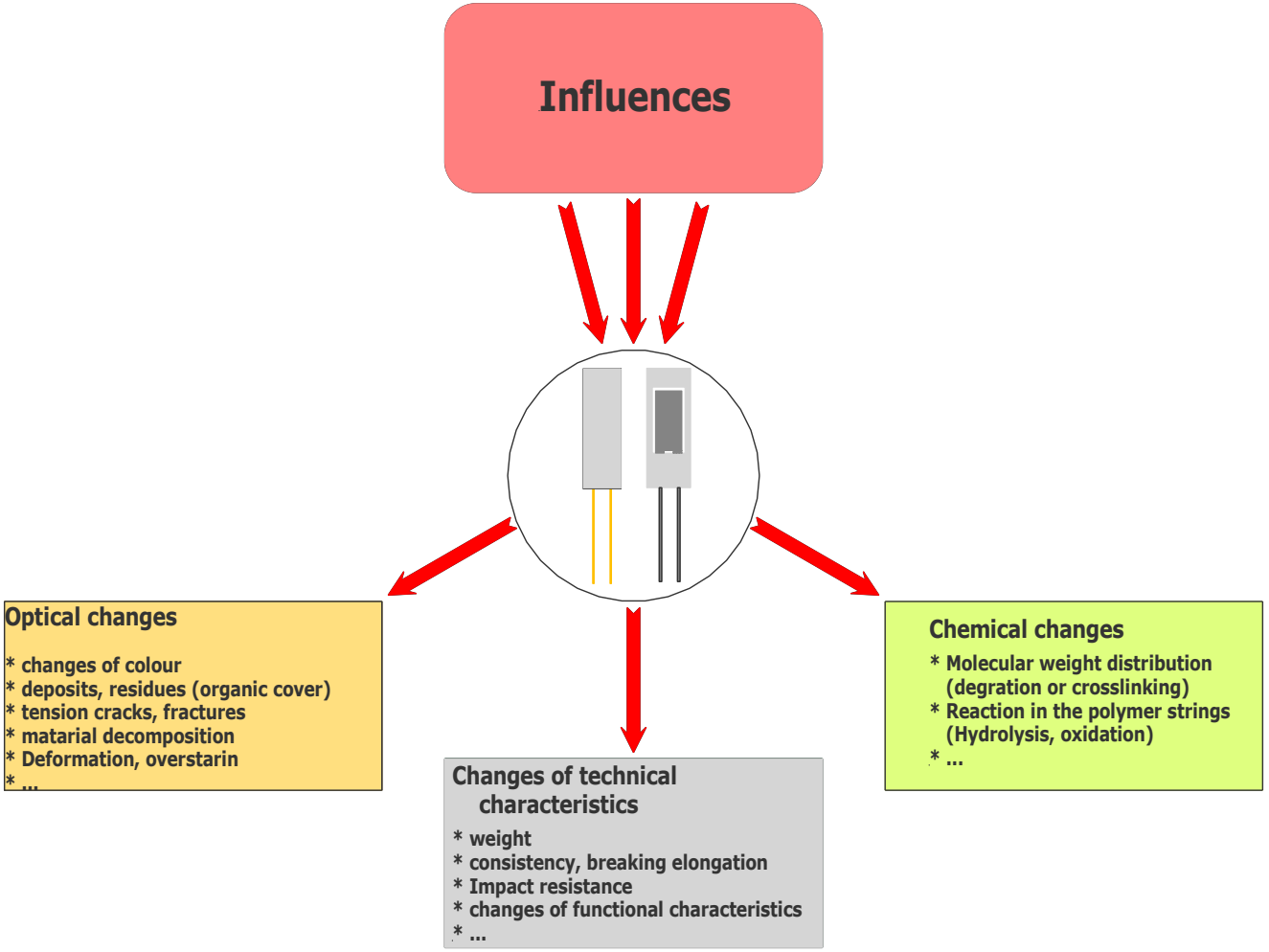
How to read technical data



Impacts acting on the sensor



Changes caused by impacts



Please fire me with questions

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Thank you for your attention

Short Break