How to identify a high quality VIP

- methods and techniques to guarantee high quality in production and application -

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What is the difference between?

vs.

Nobody asks:

- ⇨ How long does it keep vacuum?
- ⇨ How can I control the vacuum?
- ⇨ Does it work properly?

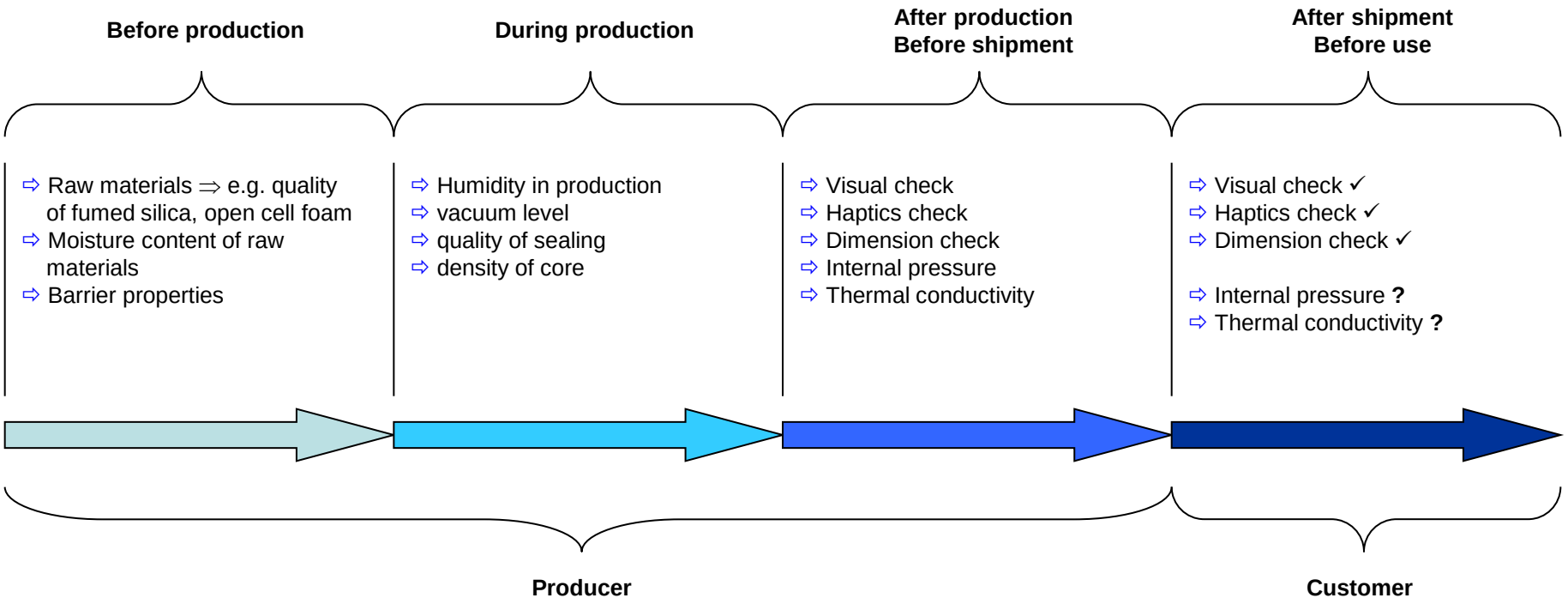
What determines the quality of a VIP?

main parameters

- Raw materials ⇒ e.g. quality of fumed silica (surface), open cell foam (cell size, open cell content)
- Moisture content of raw materials
- Humidity in production and raw material storage facilities
- Barrier properties of film
- Quality of sealing
- Vacuum level
- Density of core

Quality testing before, during and after production

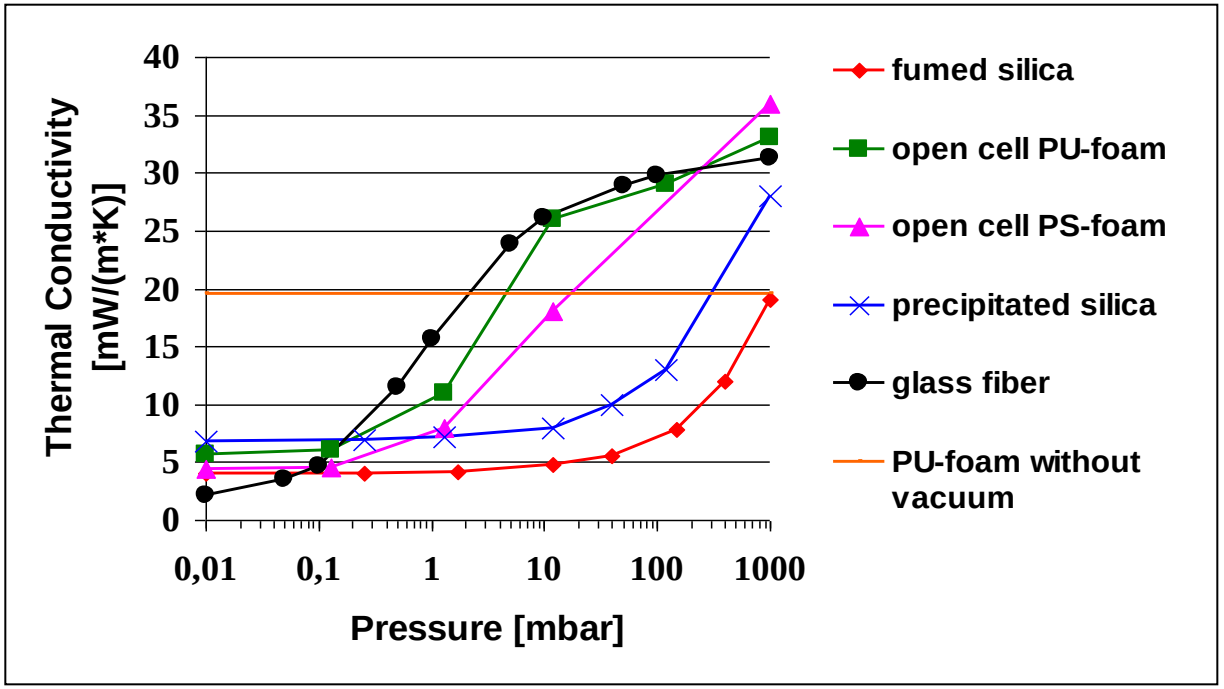
What can be done? – Who can do it?



Can VIP quality be measured?

main requirements

- ⇨ Thermal conductivity
- ⇨ Internal pressure



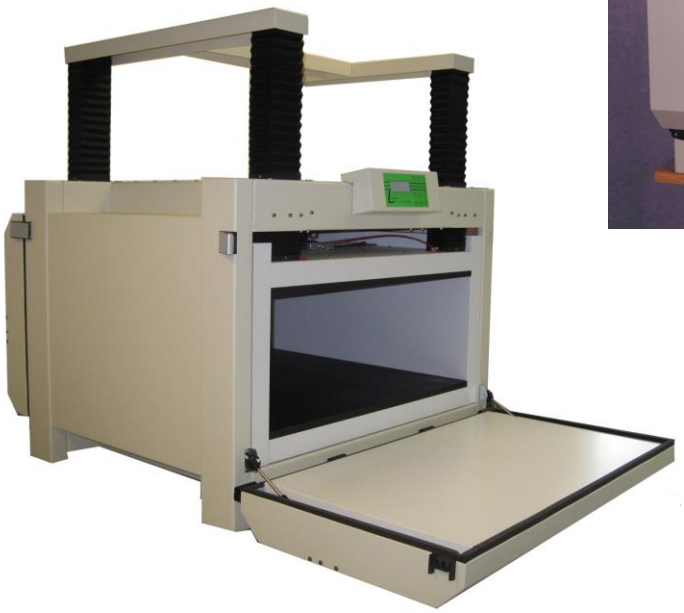
Can VIP-quality be measured?

Overview of test methods for thermal conductivity

Method	Measuring procedure		Measured parameter	What is required to determine thermal conductivity?
	direct	indirect		
Guarded hot plate method	X		Amount of heat Q	
Heat Flow method		X	Temperature difference ΔT	Calibration standard
Hot box method	X		Heat transfer coefficient U	
Insertion of solid bodies method		X	Heat flow	Calibration (λ vs. p for membrane and λ vs. p for VIP)
Measurement effusivity		X	Thermal effusivity E	Different parameters
Foil lift-off method		X	Interior gas pressure p	Laser distance measurement Calibration curve λ vs. p for VIP
Gas pressure sensor		X	Interior gas pressure p	Calibration curve λ vs. p for VIP
Gas volume sensor		X	Gas volume	Oxidisable surface (only good / bad verdict possible)
Heat Flow comparison method		X	Heat flow	Reference VIPs for calibration curve

Main VIP test methods

Guarded hot plate method



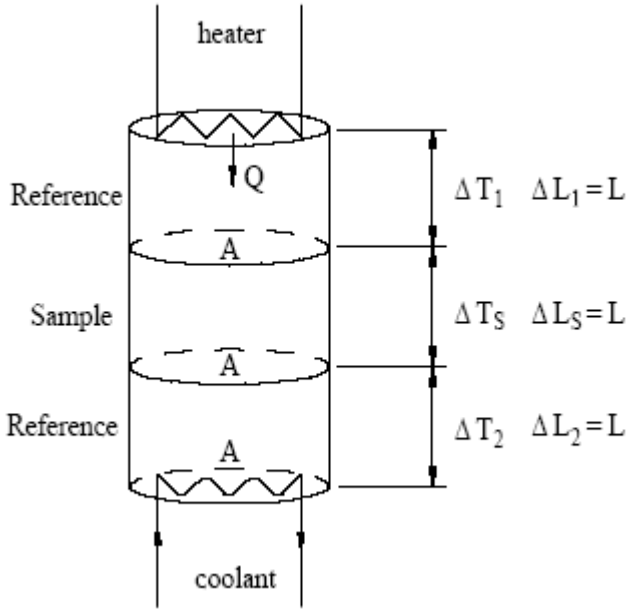
Source: LaserComp USA

Main VIP test methods

Guarded hot plate method

Function

- Energy that flows through the specimen/sample at defined surface temperatures (hot and cold plate) and specimen thickness is measured.
- Thermal conductivity is calculated out of these values independently on material and thickness
- Due to extremely low heat flow through a VIP, stabilization takes quite long



Main VIP test methods

Guarded hot plate method

Advantages

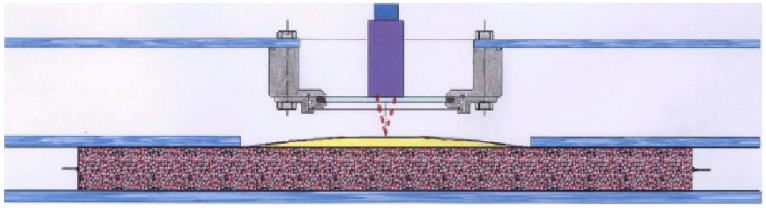
- ⇨ Very accurate/direct measurement of thermal conductivity.
  All parameters are known or determined automatically
- ⇨ Nearly no limitation (max. 760 mm width) of specimen size and thickness
- ⇨ Easy to handle, comfortable

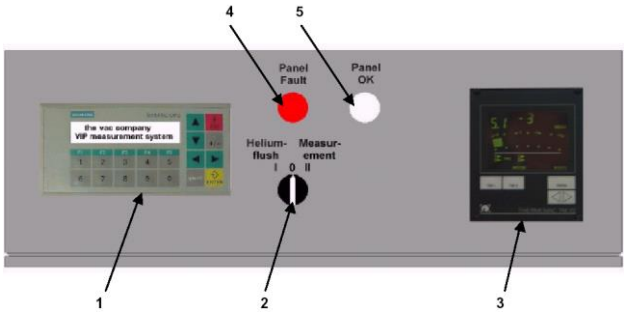
Disadvantages

- ⇨ Very slow. ~ 1 – 1,5 h per measurement
- ⇨ Not mobile
- ⇨ Expansive devices (52.000 – 100.000 $)

Main VIP test methods

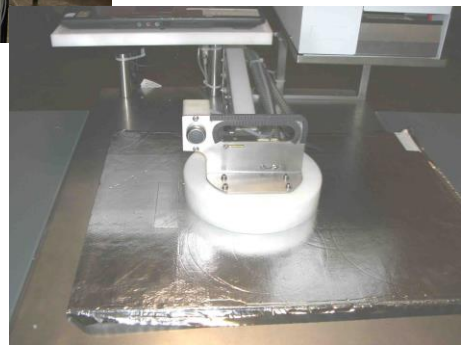
Foil lift-off method





Device installed in vacuum chamber

Source: The Vac Company GmbH



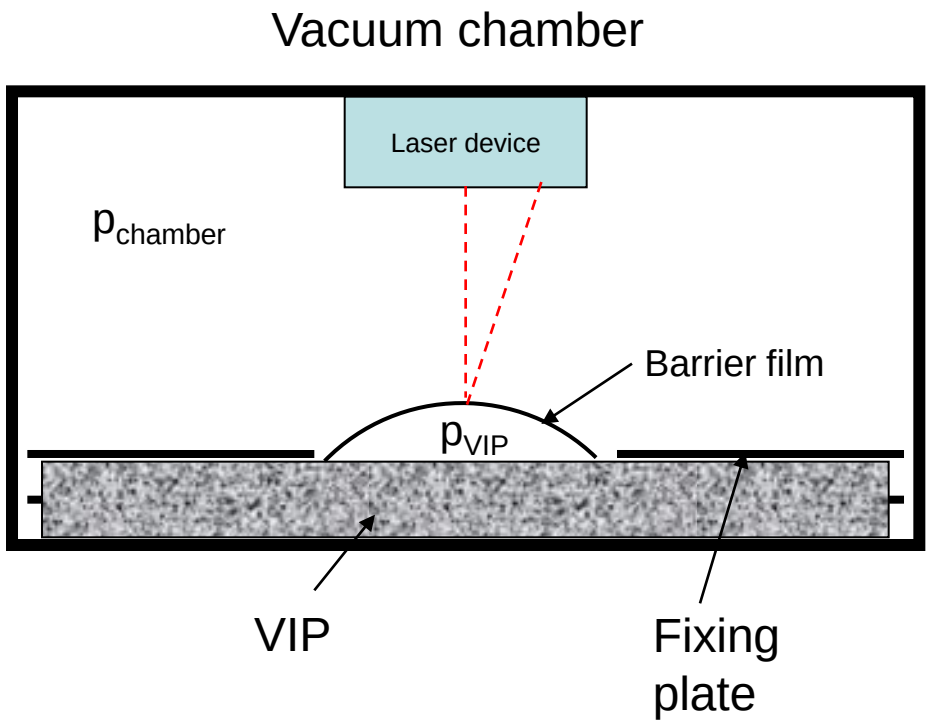
External „suction bell“ device

Main VIP test methods

Foil lift-off method

Function

- ⇨ VIP will be placed in evacuation chamber (or under suction bell)
- ⇨ Pressure inside the chamber will be reduced until gas pressure inside the VIP is higher than pressure inside the chamber
- ⇨ Foil lift-off will be detected by a laser device and pressure level will be determined automatically



Main VIP test methods

Foil lift-off method

Advantages

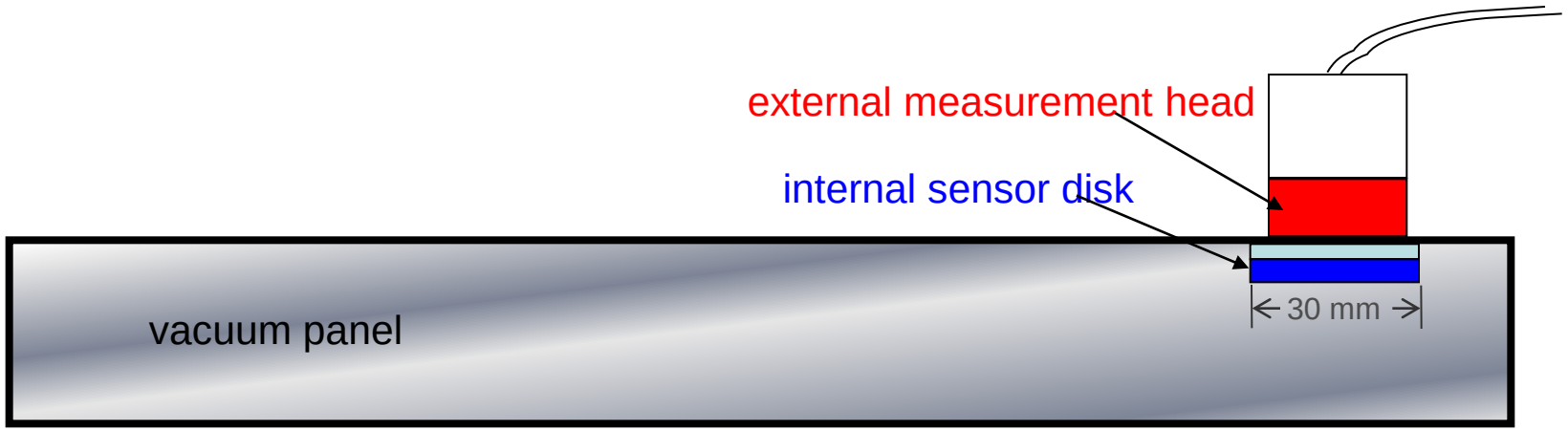
- ⇨ Very accurate measurement of internal pressure with chamber installed version
- ⇨ Nearly no limitation of specimen size and thickness

Disadvantages

- ⇨ Reasonable fast ~ 2 – 5 min (in vacuum chamber) per measurement
- ⇨ Not mobile
  „mobile version“ is not really mobile. Double check necessary due to adhesion of barrier film to core
- ⇨ Reasonable expansive
- ⇨ for 100% testing, too slow or chamber blocked for production

Main VIP test methods

Insertion of solid body method

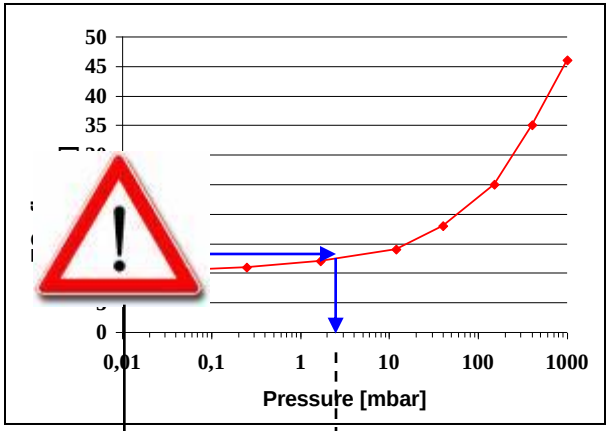


source: Va-Q-tec

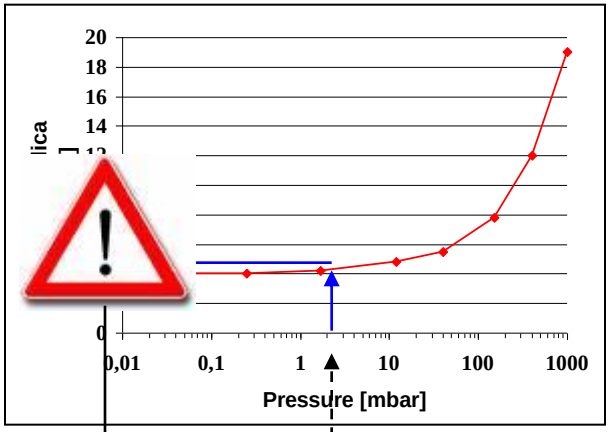
Main VIP test methods

Insertion of solid body method

Function



$\lambda \leftrightarrow p$



$\lambda_{fleece} \rightarrow p$

$p \rightarrow \lambda_{insert} = \lambda_{VIP}$

Measurement can be influenced by:
- Different temperature
- Airflow
- Incomplete surface contact
- Quality of fleece (porosity, density, moisture content etc.)

Result can be influenced by:
- Core quality / formulation
- Density
- Moisture content etc.

main VIP test methods

Insertion of solid body method

Advantages

- ⇨ Fast measurement
- ⇨ Very accurate measurement of internal pressure under defined conditions!
- ⇨ no limitation of specimen size and thickness
- ⇨ comparable cheap

Disadvantages

- ⇨ defined conditions for measurement absolutely necessary
- ⇨ Calibration curves necessary for calculate thermal conductivity value.
- ⇨ not “commercial” available, due to patent situation
- ⇨ not standardized/normed

Interim conclusion

Various methods are available, but …

either

to slow,
to expansive,
too sensitive (temperature etc.),
not mobile

or

fast enough, but …
indirect measurements,
too sensitive (needs defined measurement conditions) → not reliable enough
not “free” available
not contact free

What would be desirable

The ideal measurement device

Measurement device / sensor for thermal conductivity and inner pressure

- ⇨ very accurate
- ⇨ contact free / remote monitoring
- ⇨ independent of external influences (temperature, airflow etc.)
- ⇨ saved historic values “on board” for serious lifetime calculation
- ⇨ small / light weight
- ⇨ easy to handle
- ⇨ reasonably priced

What can be done

Cross-linked quality system

Quality certification

Measurement devices

Customer training

Product protection

What can be done

Solutions, to increase quality level and customer confidence

⇨ Quality certification ⇒ e.g. ISO 9001

DIN EN ISO 9001:2000

Zertifikat: 01 100 030449

⇨ External control of producers ⇒ e.g. compulsory in connection with DIBt approval → Ü-Label

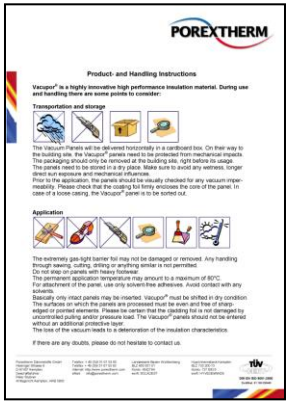
What can be done

Solutions, to increase quality level and customer confidence

⇨Quality label ⇒ RAL – VIP quality label

RAL GÜTEZEICHEN
VIP Vakuum Isolations Paneele

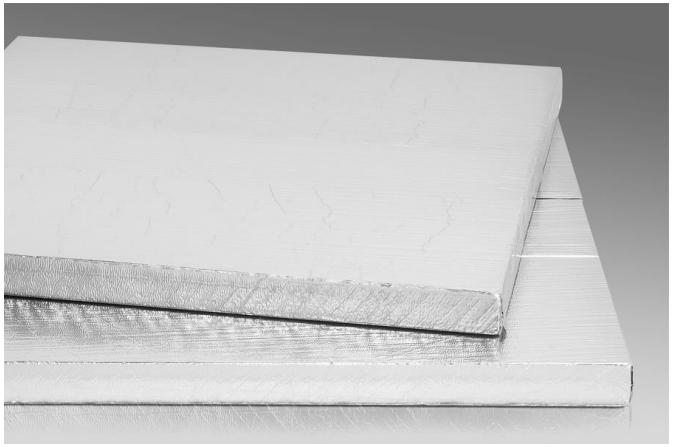
⇨ labeling / handling instructions



What can be done

Solutions, to increase quality level and customer confidence

⇨ panel protection



What can be done

Solutions, to increase quality level and customer confidence

⇨ panel protection

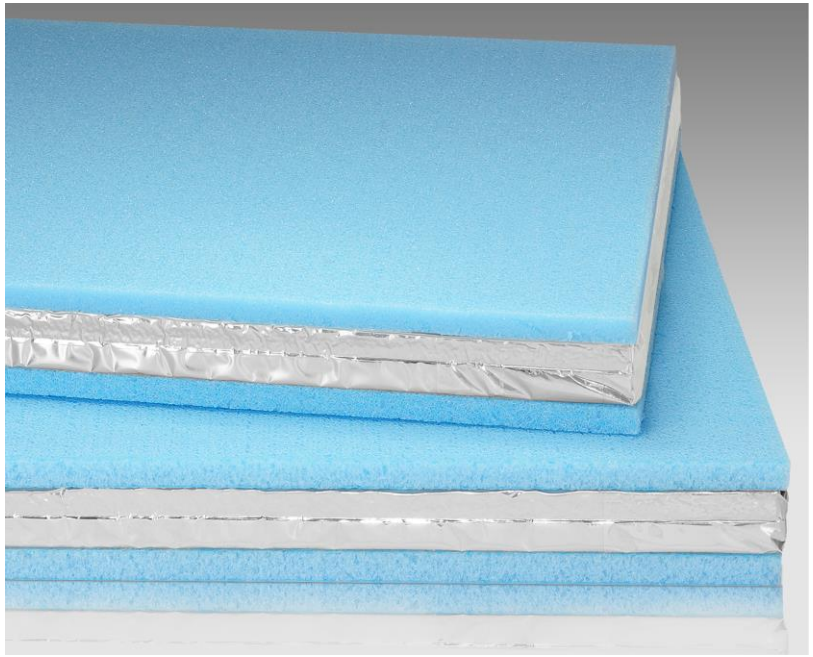
protection layer – rubber granule mat

protection layer – EPS

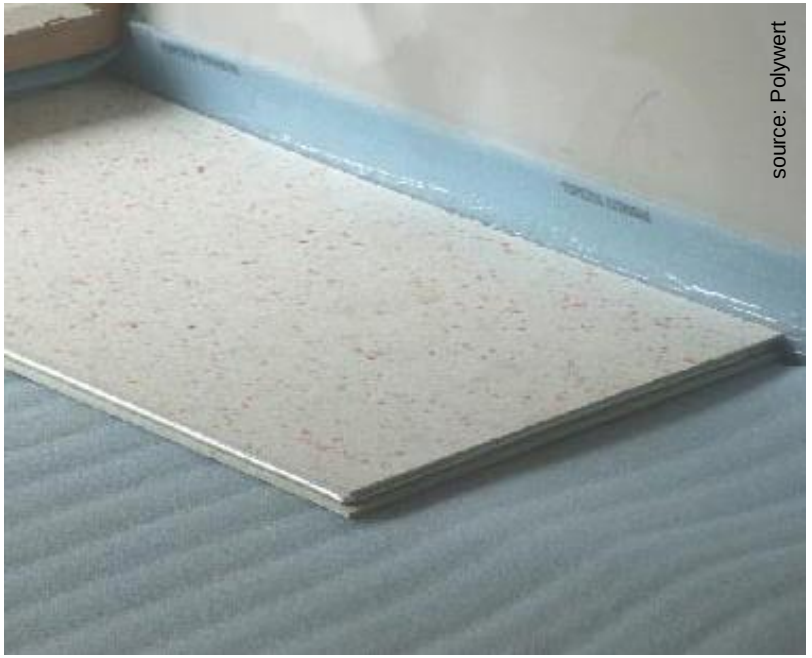
What can be done

Solutions, to increase quality level and customer confidence

⇨ panel protection



protection layer – XPS



protection layer – Polyester fiber mat

What can be done

Solutions, to increase quality level and customer confidence

⇨ panel protection

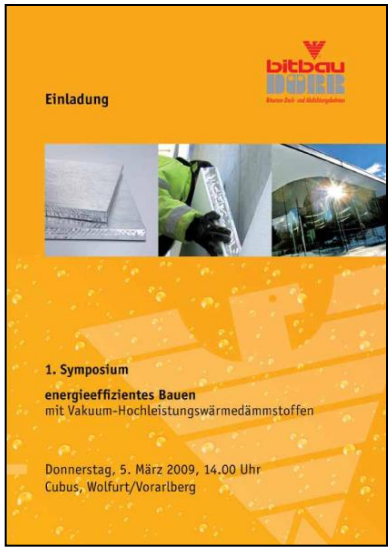
plaster-based sheeting

with PVC-frame

What can be done

Solutions, to increase quality level and customer confidence

⇨ training



Conclusion

- Lot of suitable measurement devices are available, but a very accurate, robust, reliable, easy to handle and reasonable cheap system is not available yet.
- Quality is not create by measurements but in a serious, controlled production and production process
- Quality can only be obtained by users that are aware of the sensitivity of the product
- Sensitivity of the product can be reduced by intelligent protection

High quality can only be achieved by producers with an extremely high quality approach and customers/users that know and respect the limitations of the product.

Thank you for your attention