BAM
Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

HiPerMat 2016

COMPOSITE FAÇADE ELEMENTS WITH FUNCTIONAL SURFACES

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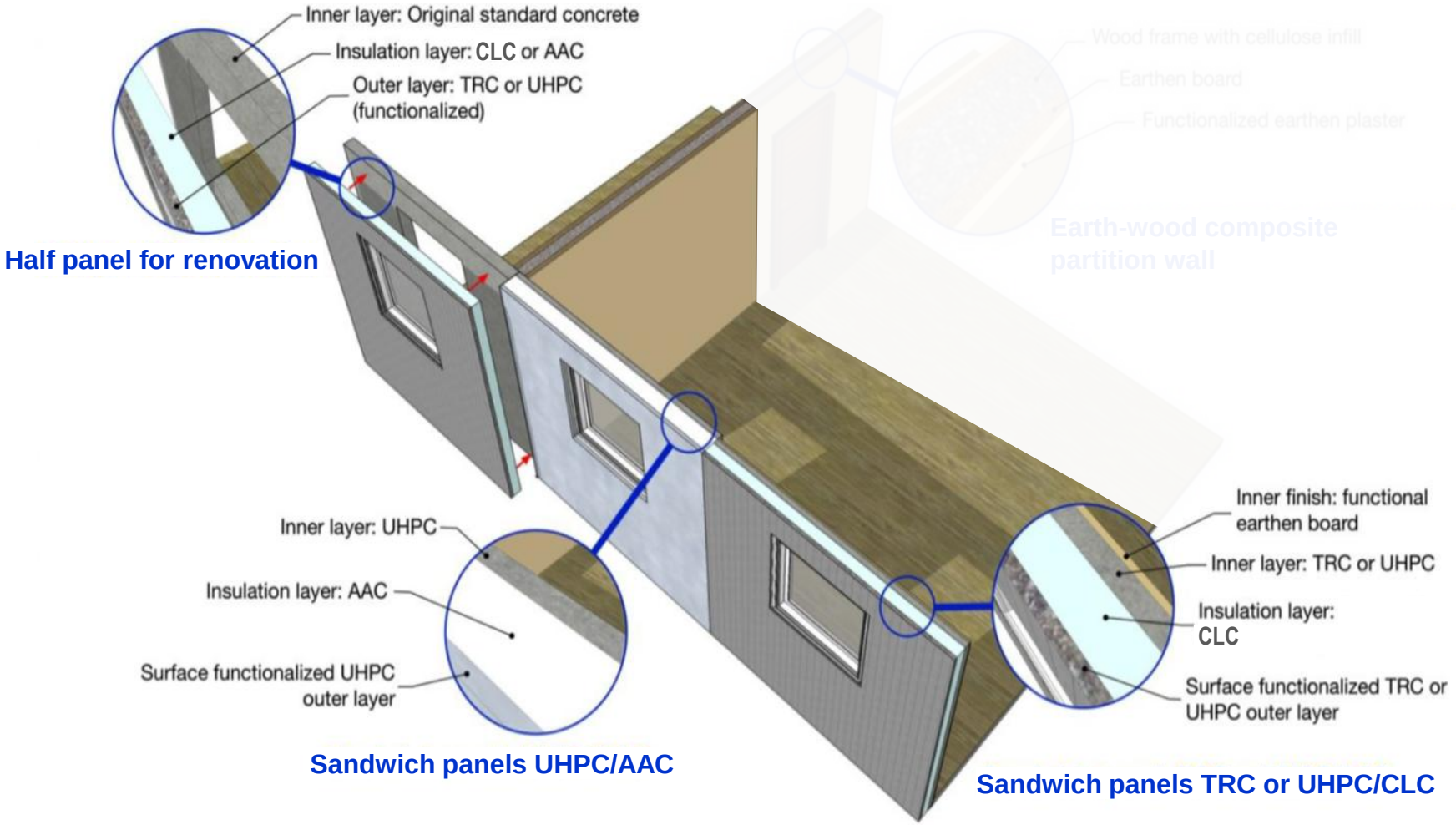
Outline

- [H]house project
- Element design
- Material properties
- Functional surfaces
- Conclusions and outlook

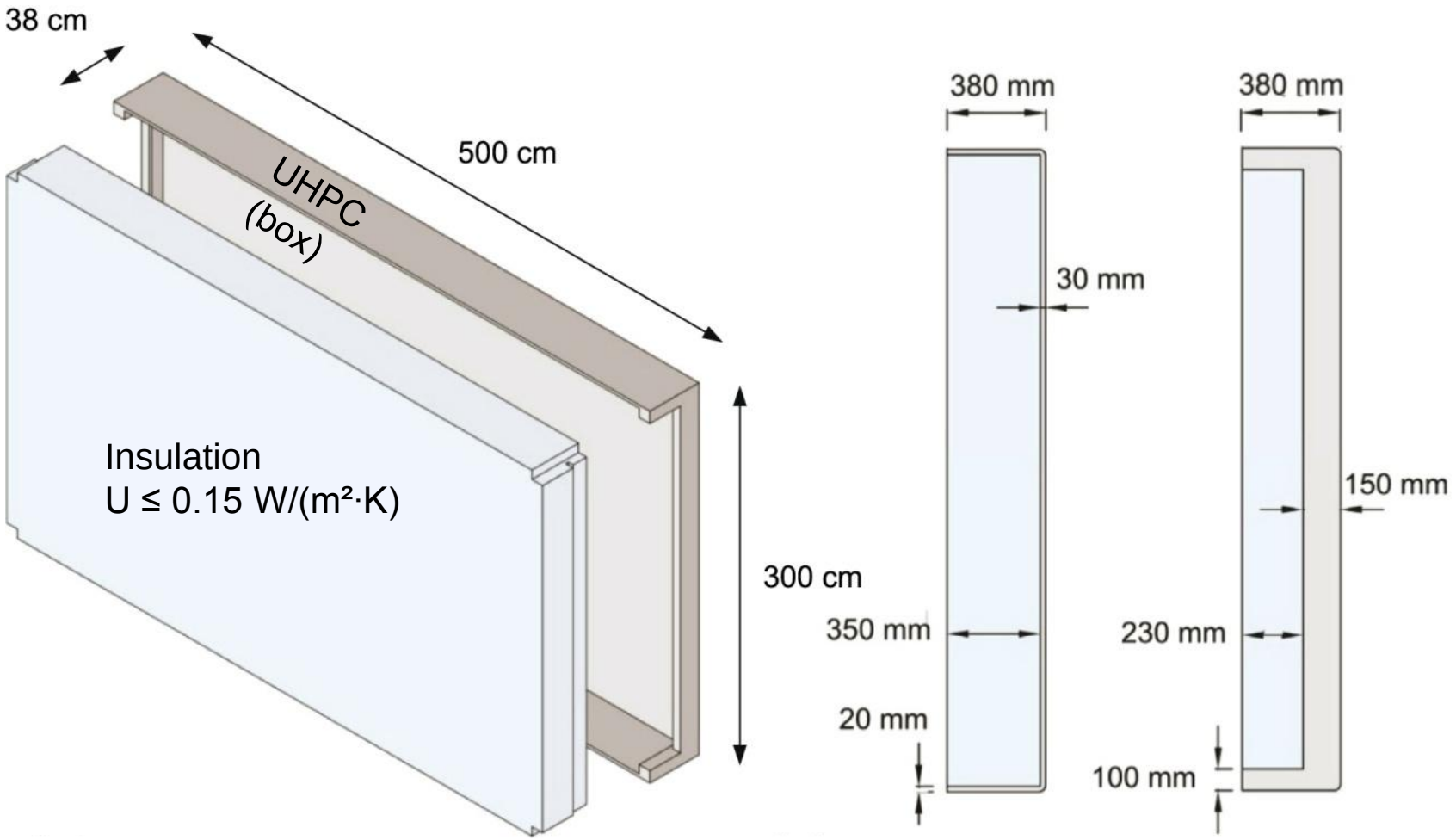
[H]house project
Concept



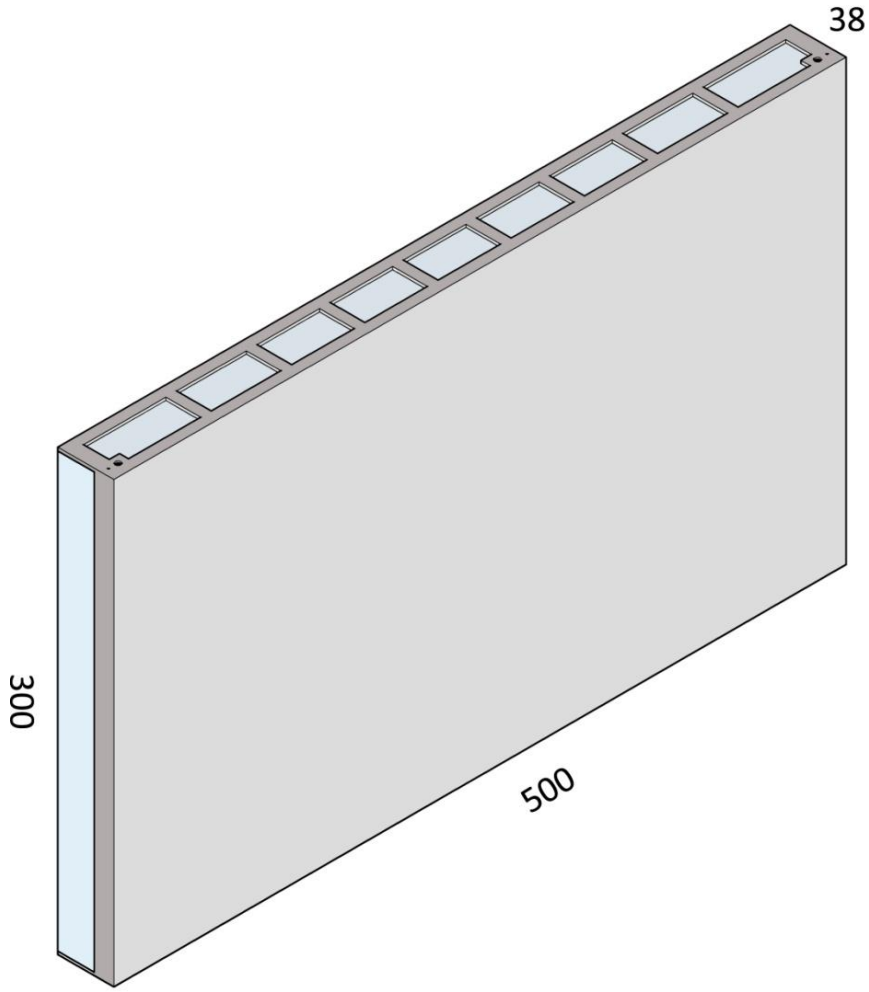
[H]house project
Goals

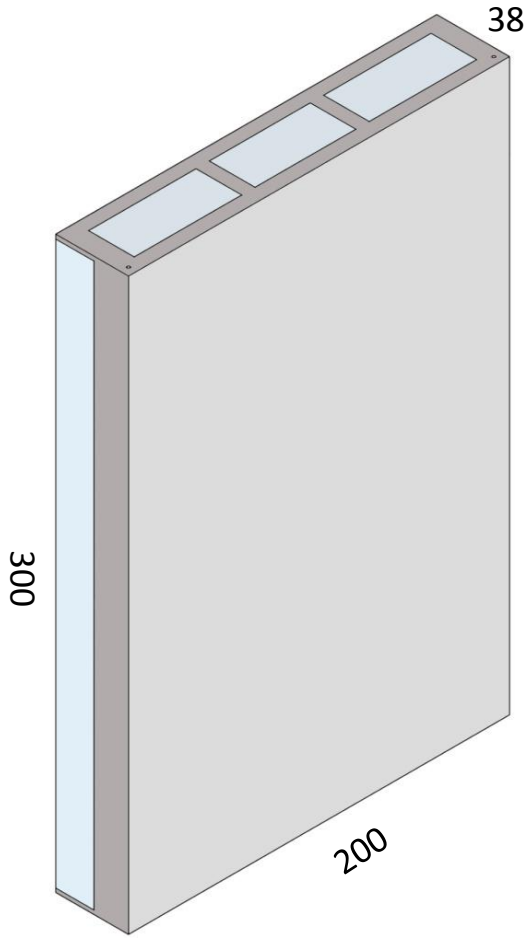
- UHPC composite precast elements with insulation made of Autoclaved Aerated Concrete (AAC) or Cellular Lightweight Concrete (CLC) for refurbishment and new construction
- Additional increase of sustainability of the light-weight construction by use of binders with reduced clinker content
- Self-cleaning element surfaces
  - Photocatalysis
  - Super hydrophobicity

Element design

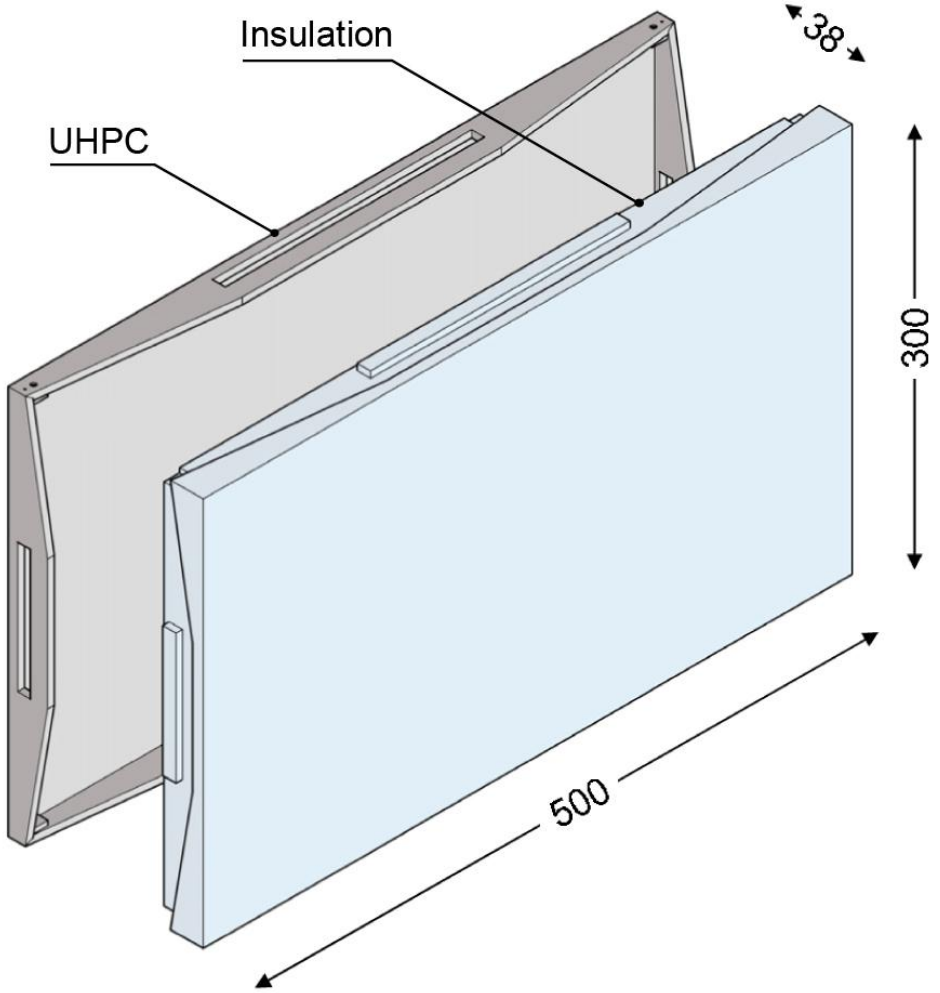


Element design





Element design



Materials
UHPC

Dyckerhoff Nanodur® Compound:
Particles < 250 µm
Portland cement, blast furnace slag, quartz powder, synthetic silica

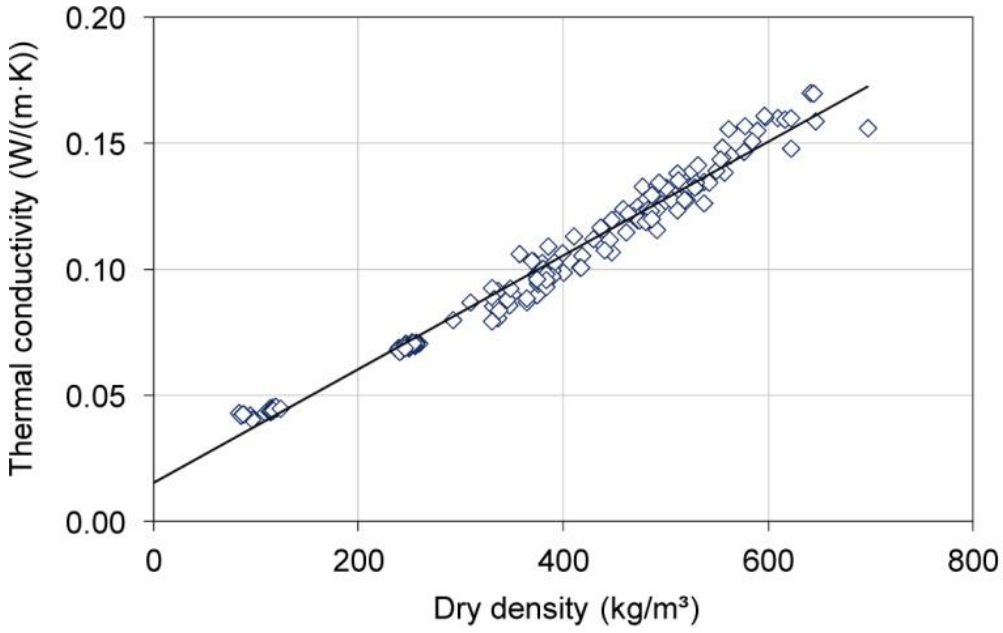
Material	Reference	1% TiO_2	3% TiO_2	5% TiO_2
Nanodur® Compound	1050	1028	984	940
Sand 0/2 mm	1150	1150	1150	1150
Titaniumdioxide (TiO_2)	--	22	66	110
PCE superplasticiser	17.9	30.0	53.3	80.0
Water	178.5	178.5	178.5	178.5

→ **Compressive strength > 100 MPa (> 50 MPa after 1 day)**

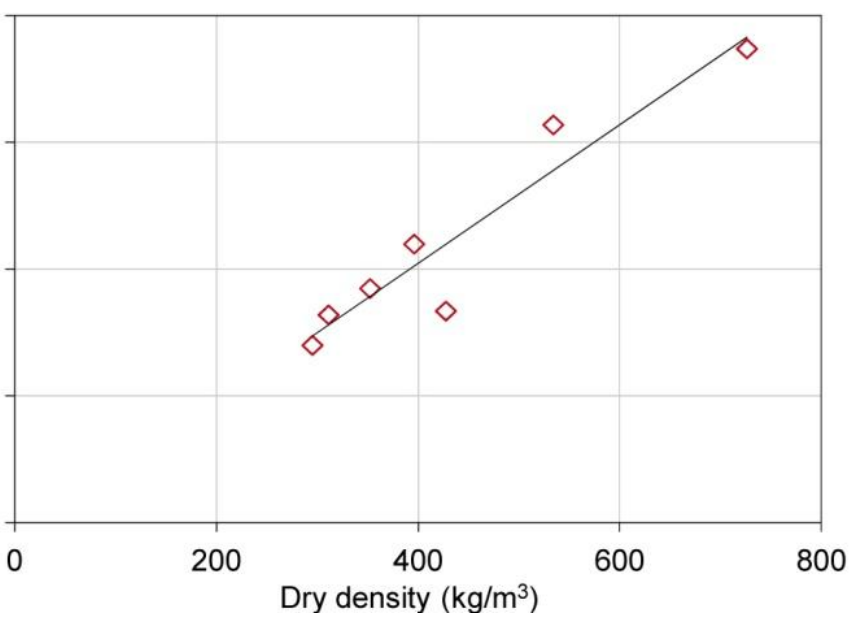
Materials
Insulation – AAC/CLC

Xella Multipor®: λ = 42-47 mW/(m·K), 85-115 kg/m³
Aercrete/CBI CLC: λ < 45 mW/(m·K) at 150 kg/m³ → Quartzene® aerogel

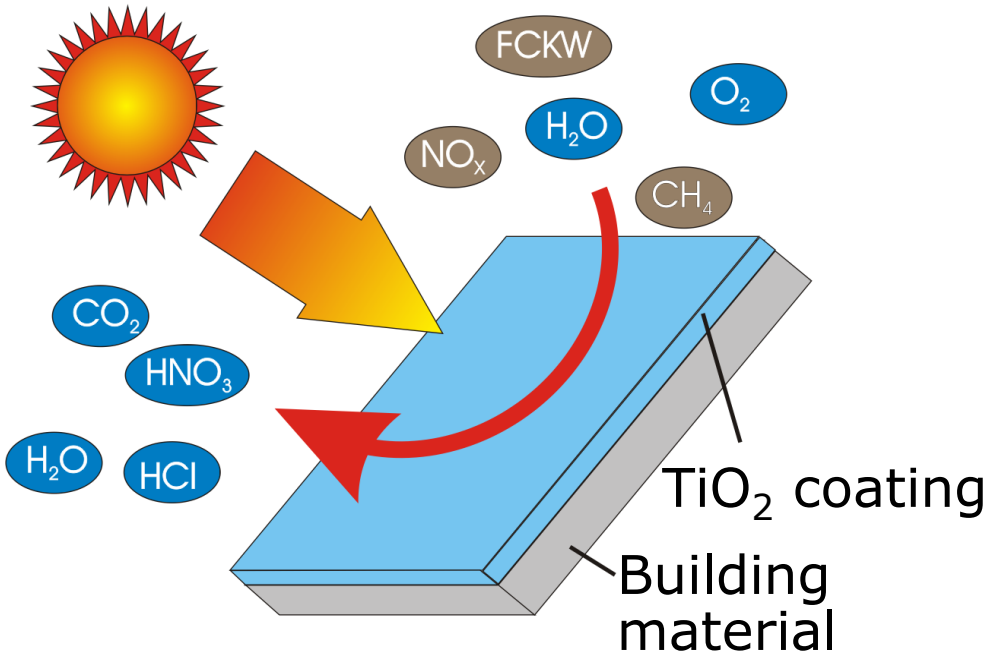
AAC



CLC



Functional surfaces
Photocatalytic self-cleaning



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Decomposition of organic material

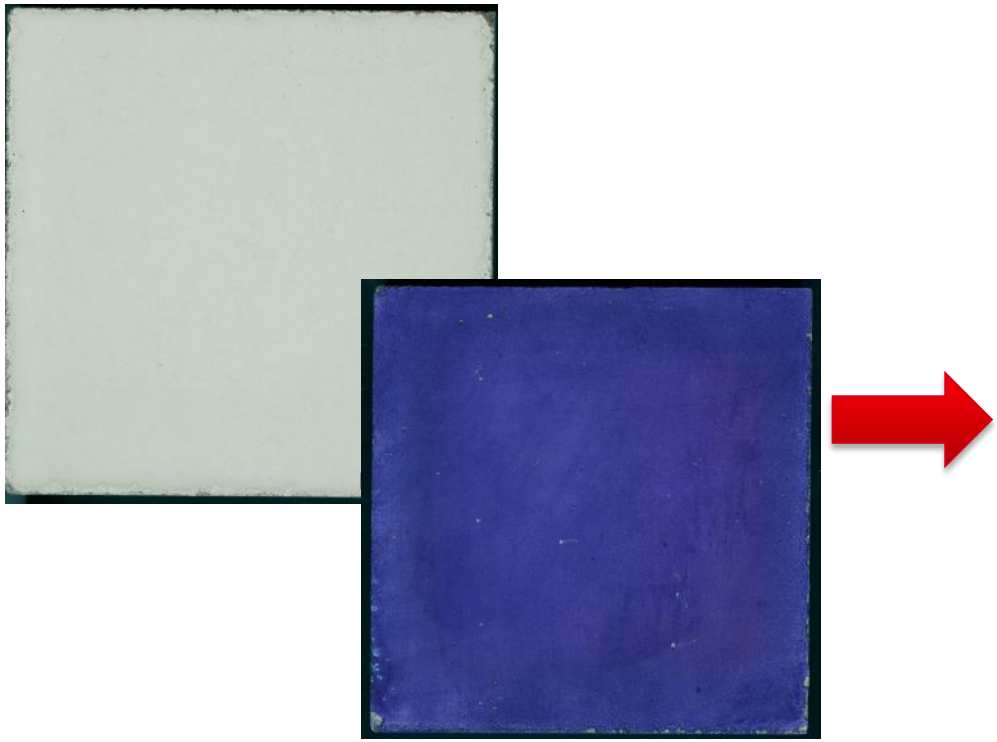
Removal of decomposed matter by draining rainwater or wind

Side effect:

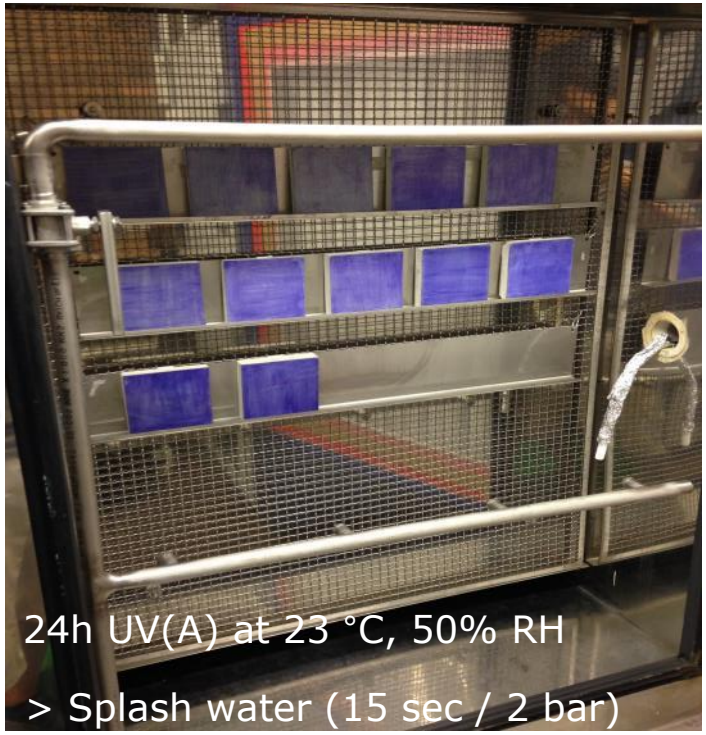
Reduction of airborne pollutants

Functional surfaces
Photocatalytic self-cleaning

Pollution with methylene blue

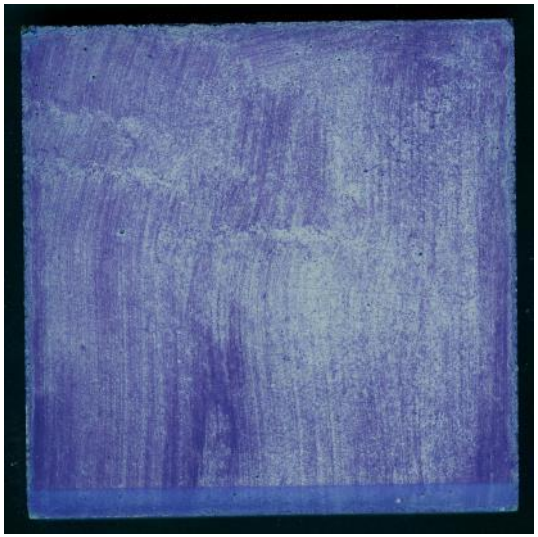


Artificial weathering

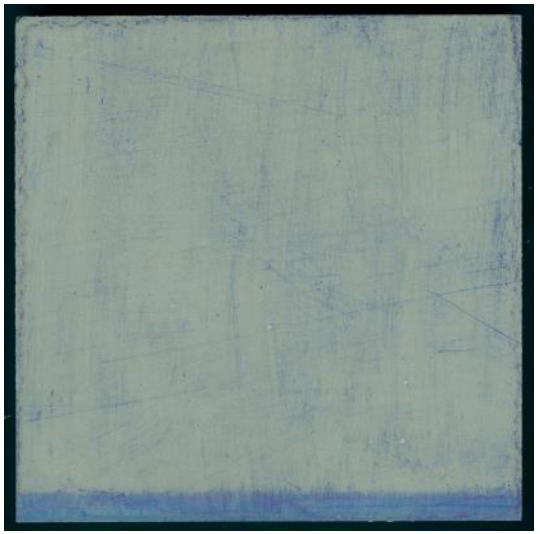


Functional surfaces
Photocatalytic self-cleaning

Initial state



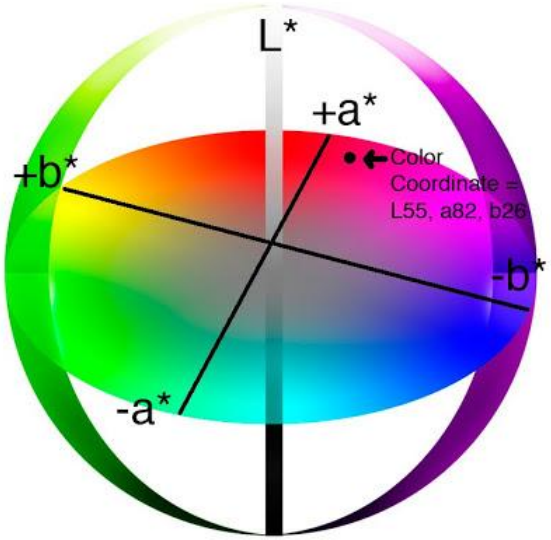
After 24 h UV(A)

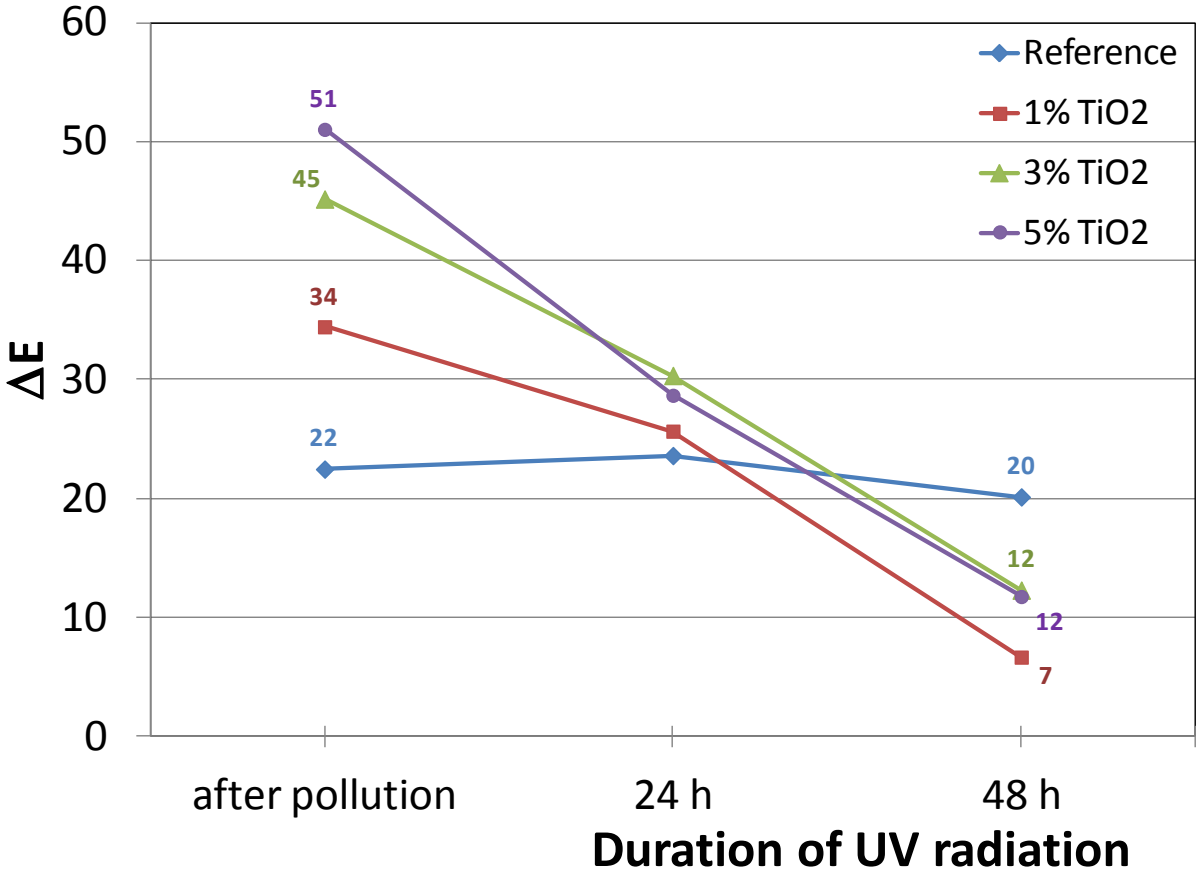


After 48 h UV(A)

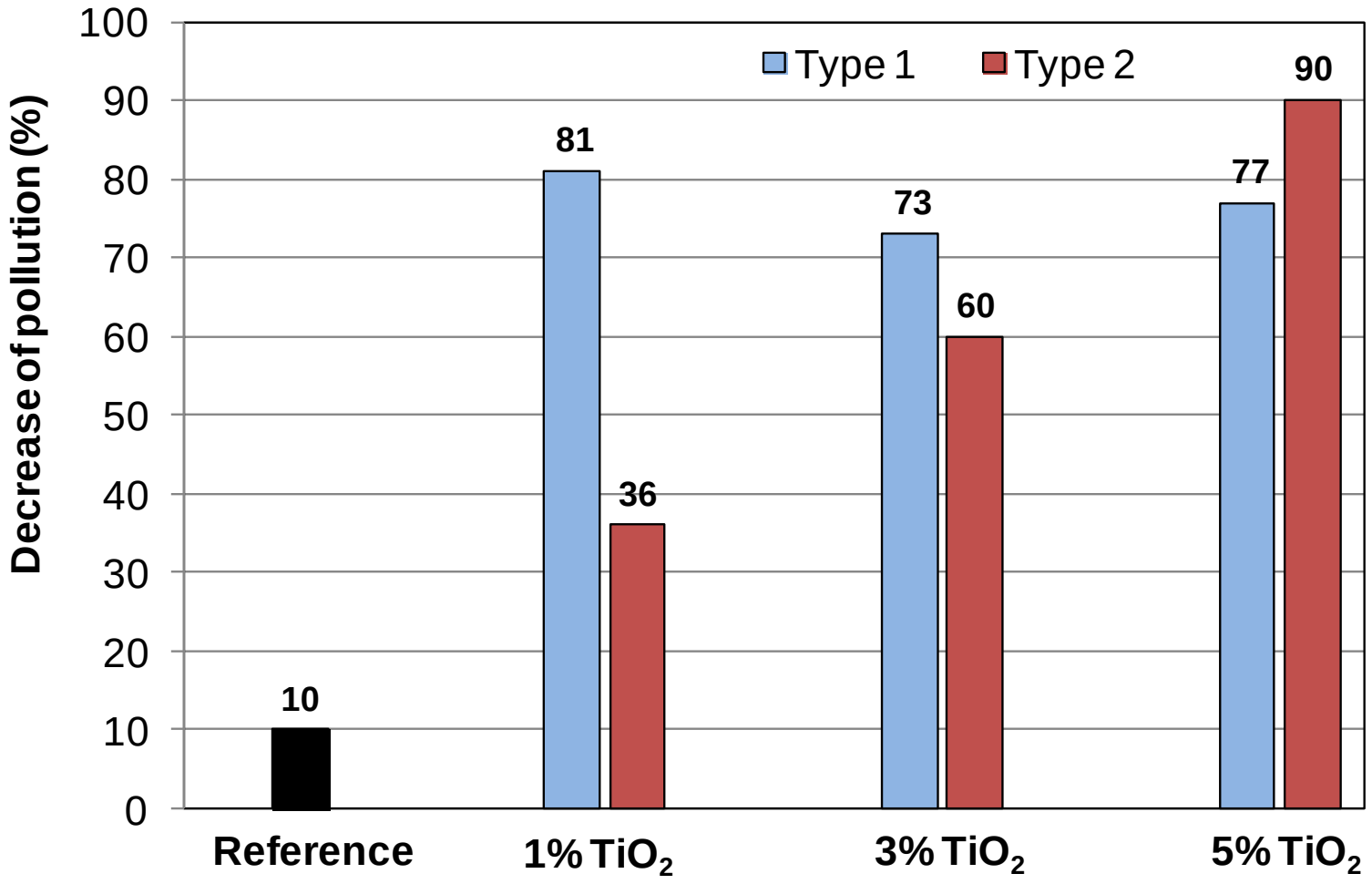
Functional surfaces
Photocatalytic self-cleaning

L*-a*-b* colour space



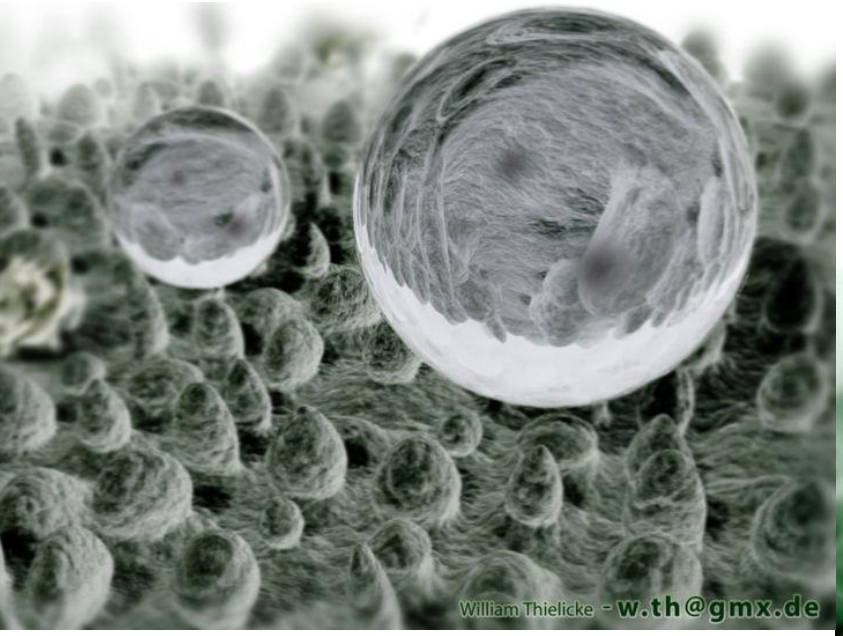


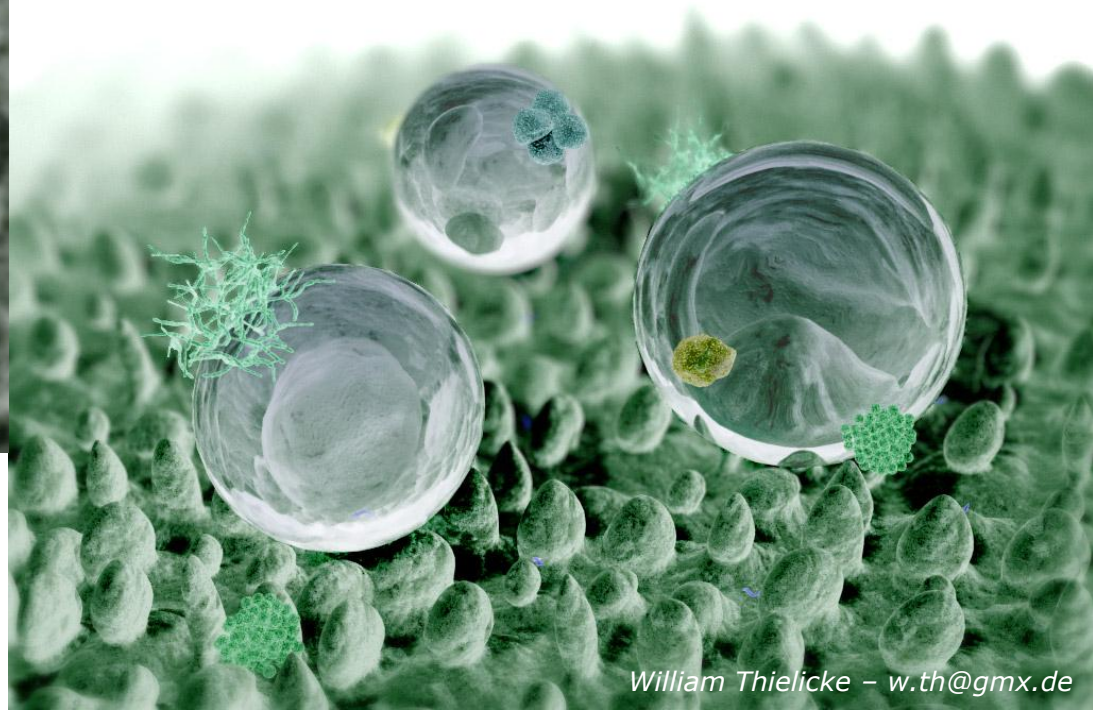
Functional surfaces
Photocatalytic self-cleaning



Functional surfaces
Super hydrophobicity

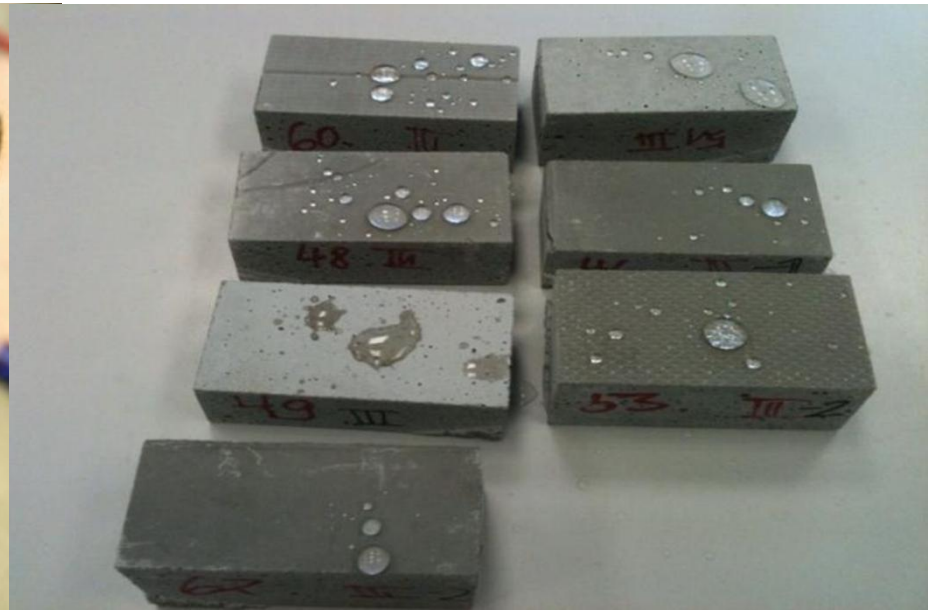
Lotus effect





Functional surfaces
Super hydrophobicity

Micro structuring with technical fabrics

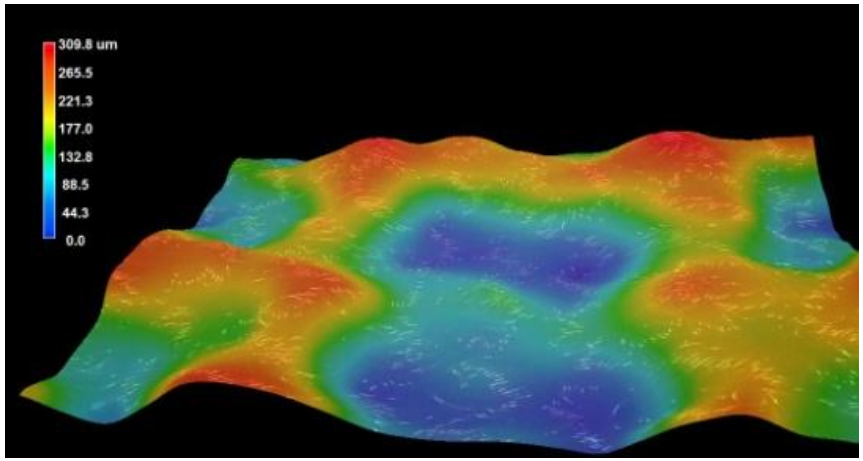


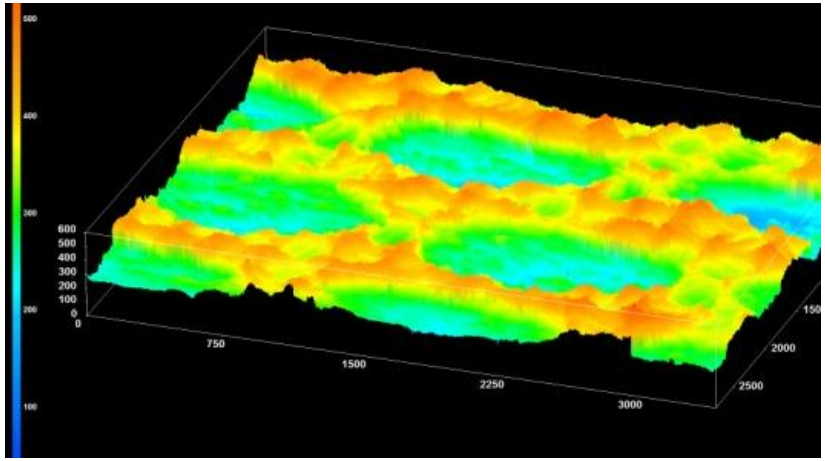
CBI

Functional surfaces
Super hydrophobicity

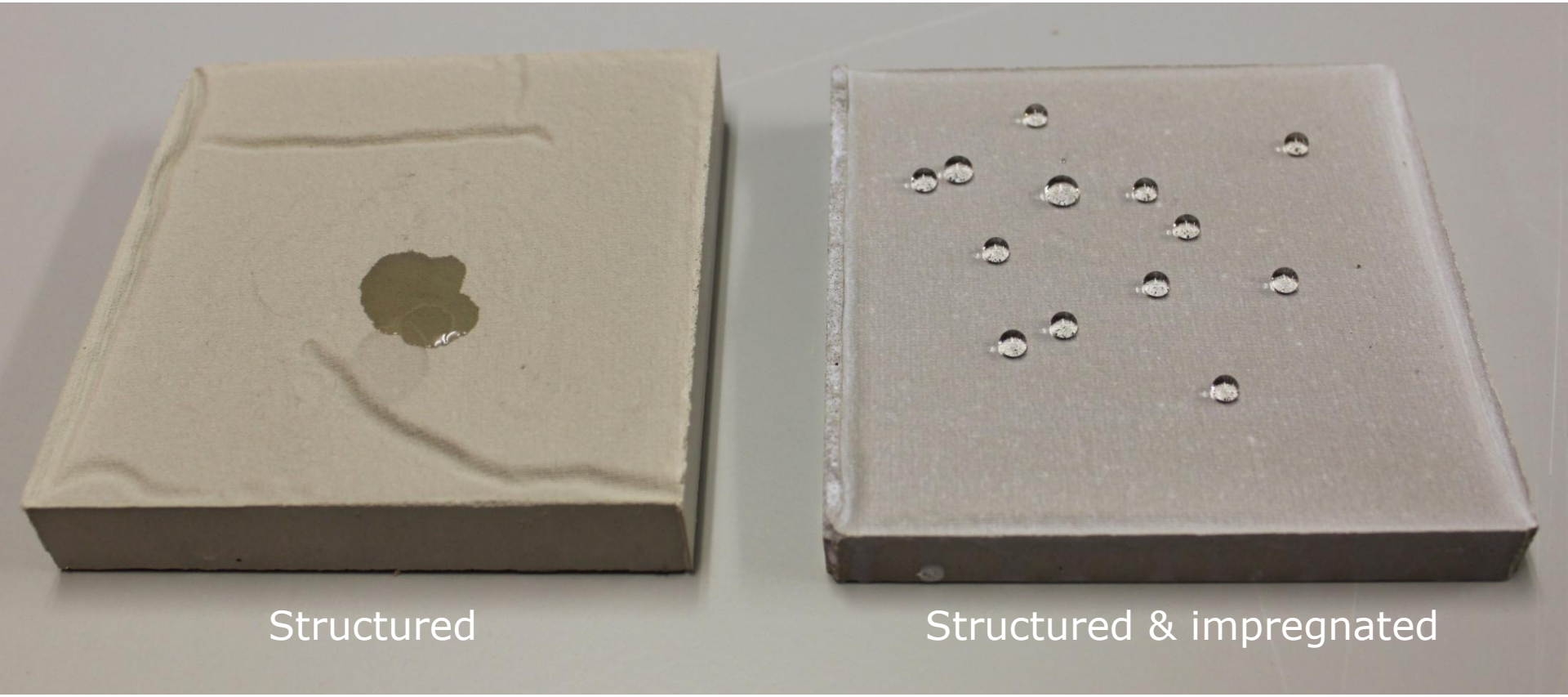
Fabric

UHPC





Functional surfaces
Super hydrophobicity



Functional surfaces
Super hydrophobicity

Functional surfaces
Super hydrophobicity

Test series with several silane/siloxane based agents

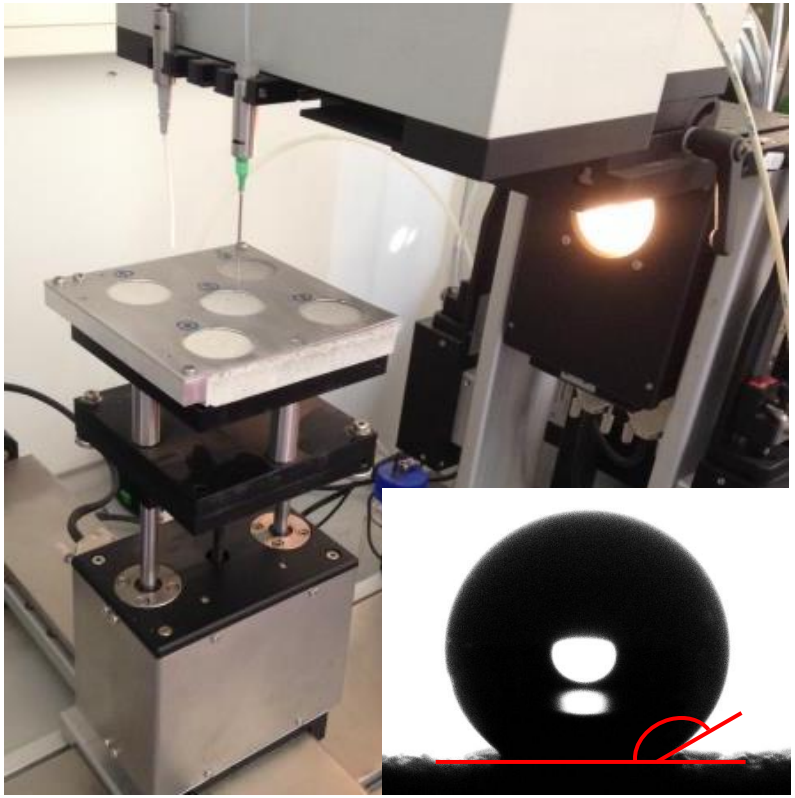
- Series 1:
  UHPC cast on fabric, impregnation 24 h after demoulding

- Series 2:
  UHPC cast in formwork (PVC) without fabric, impregnation 24 h after demoulding

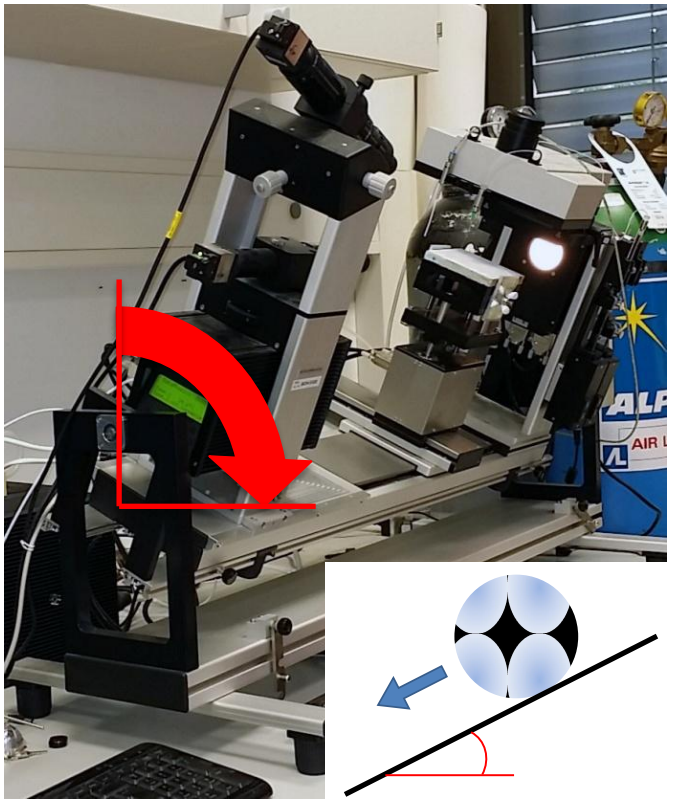
- Series 3:
  Application of agent on fabric before UHPC cast

Functional surfaces
Super hydrophobicity

Contact angle

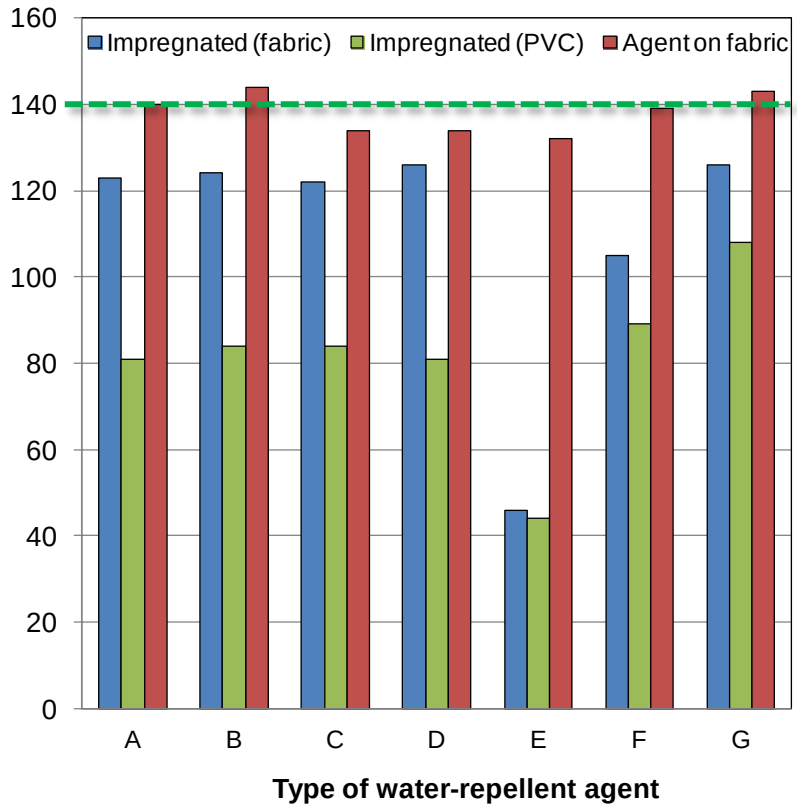


Roll-off angle

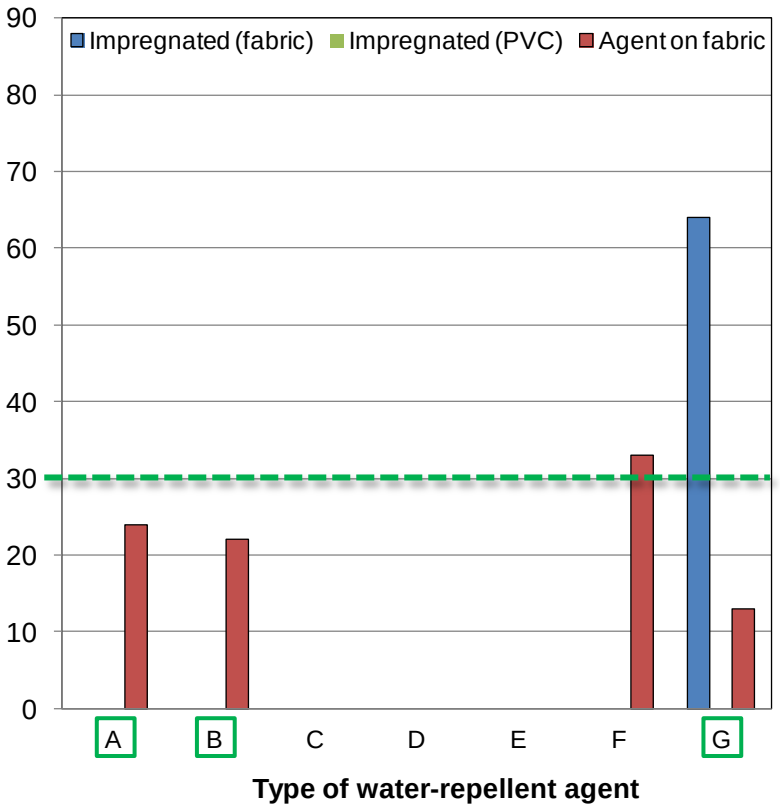


Functional surfaces
Super hydrophobicity

Contact angle



Roll-off angle

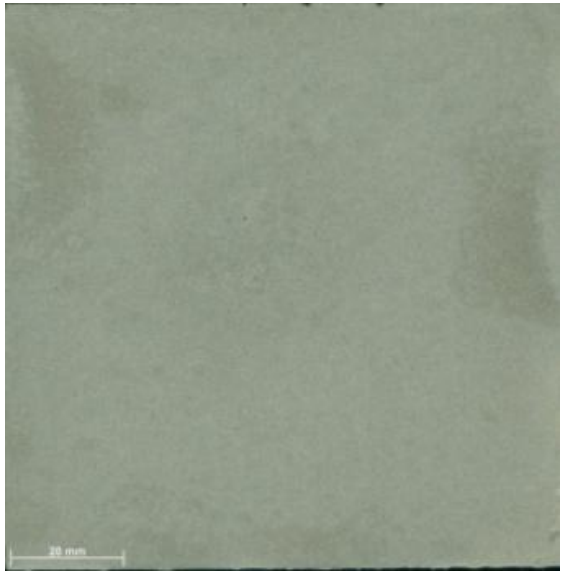


Functional surfaces
Super hydrophobicity

Agents applied with paintbrush on fabric before concrete cast


Type A


Type B


Type G

Functional surfaces
Super hydrophobicity

Conclusions and outlook

- Fabrics suitable for manufacture of micro-structured UHPC, but tend to swelling and deforming
- Application of water-repellent agent on fabric substrate before concrete cast most efficient
- Excellent water repellence obtained with silane-based agents
- Concept of box-shaped UHPC is a simple and robust solution for the composite façade elements

→ Consistently good performance of water repellence after preliminary artificial weathering tests

→ UHPC with water-repellent and with photocatalytic surfaces currently exposed to urban environment

→ Numerical modelling to identify heat bridges and to find optimum compromise between structural and hygrothermal performance

Acknowledgements

[H]house

www.h-house-project.eu

H-HOUSE is a research project funded by the European Commission under the 7th Framework Programme (Grant Agreement No. 608893)

The authors thank also Mr. Erdi Kaplan and Mr. Serdar Bilgin for their important support in experimental testing and data analysis.