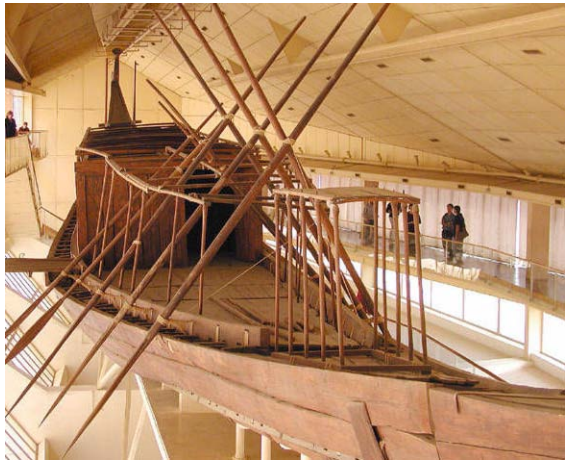

Silicone based solutions for sustainable building protection

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Birmingham
April 14, 2010

EVONIK INDUSTRIES

Agenda

- General introductive comments
- Portland cement and impact on environment
- Water up-take and consequences
- Water repellence through silicone compounds
- Conclusions

Applications of silicones

Sealants

Personal care

Fuel defoamer

Foam stabilizer

Textile softening

Leather treatment

Automotive

Paper coating

Building protection

Building protection adresses megatrends

Growth and aging of world population

Urbanization and metropolization

Energy demand and climate impact

Mobility & communication

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Growth and aging of world population

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Durability
Longer restauration cycles

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Durability
Longer restauration cycles

Economy
Cost saving
Energy efficiency

Building protection adresses megatrends

Growth and aging of world population

Urbanization and metropolization

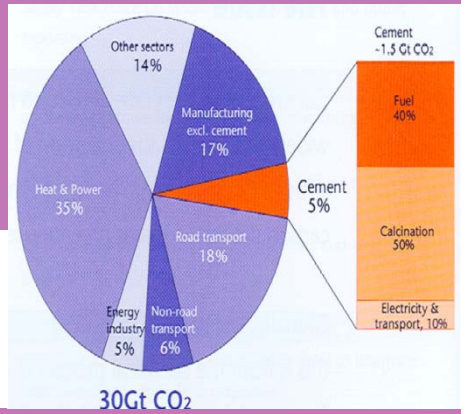
Energy demand and climate impact

Mobility & communication

Durability
Longer restauration cycles

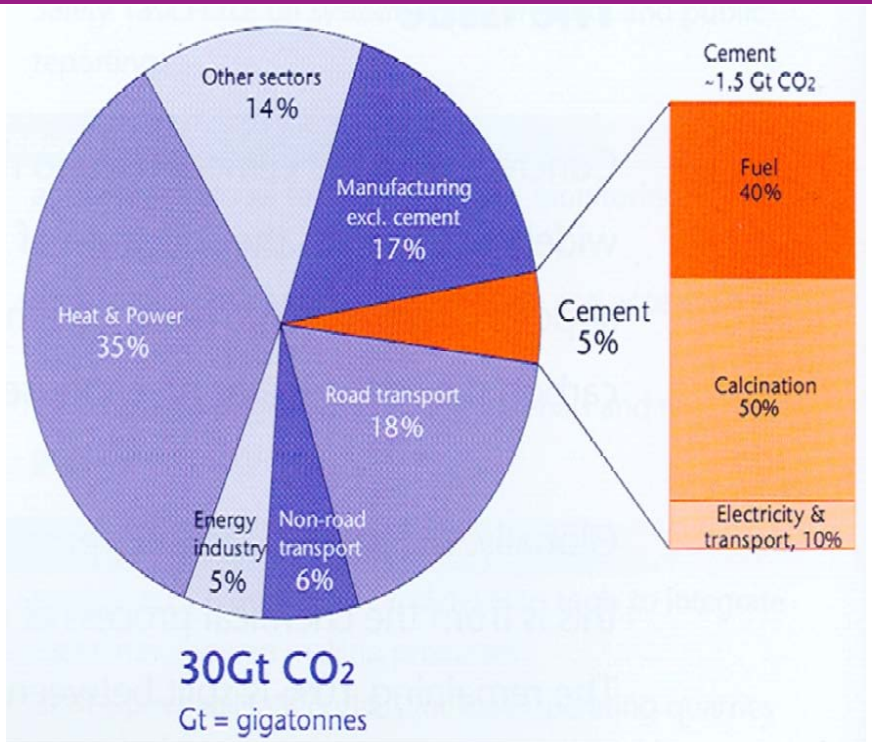
Economy
Cost saving
Energy efficiency

Aesthetics
Design

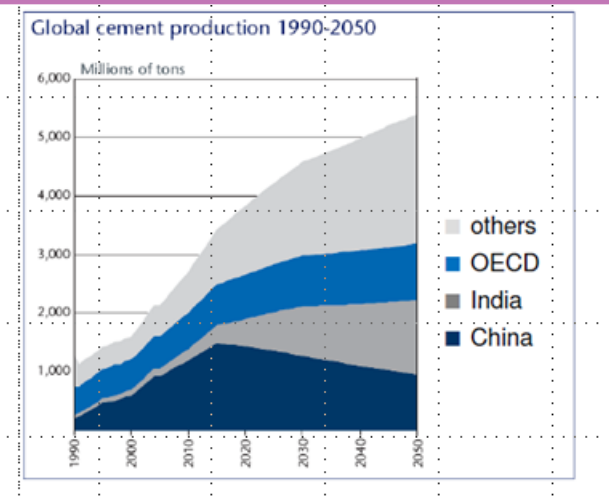


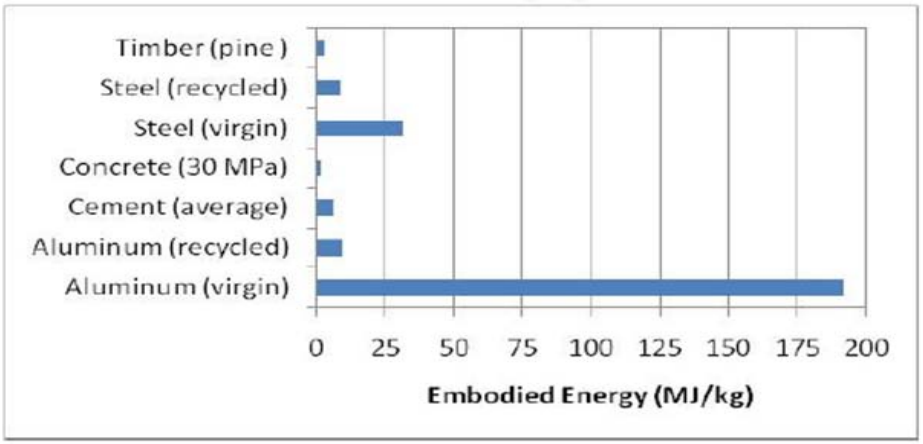
Sustainability
Saving resources and environment

Production of Portland cement and CO_2 emission



- almost 3 GT/a corresponds to 1 m^3/pers.
- 5 % of ww CO_2 emissions
- 1 t Portland cement:0,87 t CO_2
- Demand is increasing





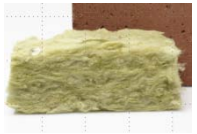
- CO_2 t/inhabitant in 07:
- US 19.1
- G 9,7
- GB 8.6
- Canada tax is 13 €/t emission

CO_2 balance of Portland cement

why water repellence ???

- Rising damp
- Damaged Facades
- Micro-organism
- Poor Insulation
- Corrosion
- Mechanical Damage



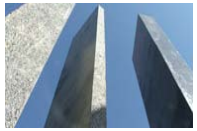
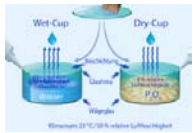


Damages through moisture

- Water repellence
- Coloration
- Efflorescence control
- Soil release
- Surface modification
- Breathability



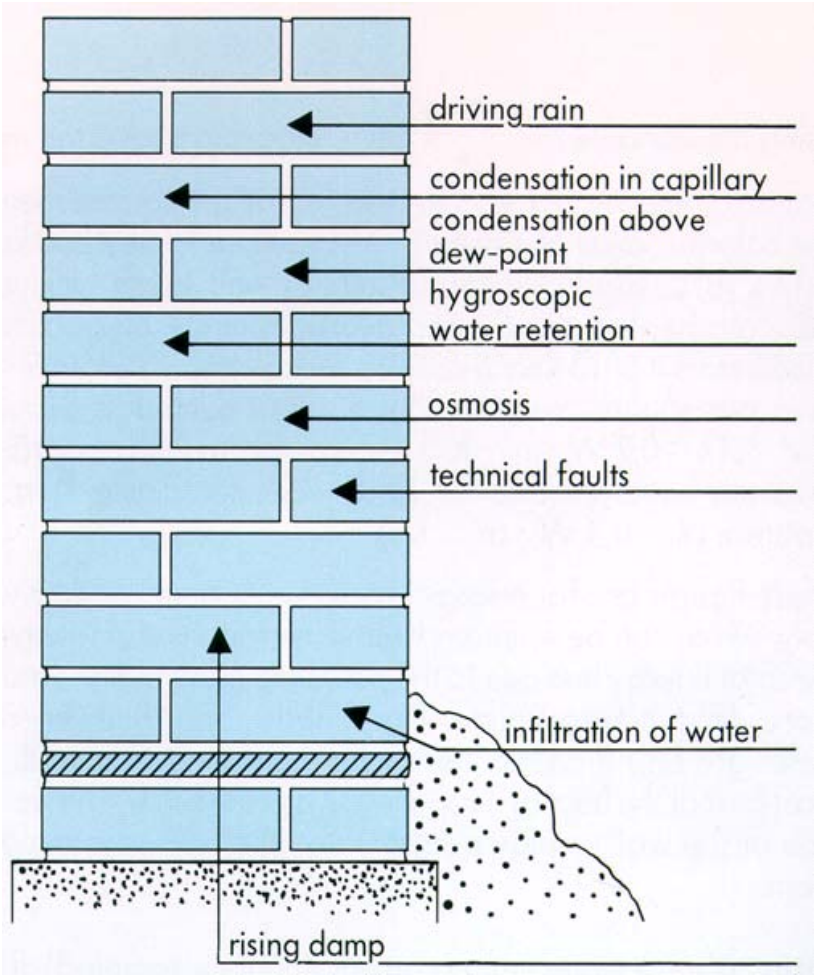


Silicone additives to support

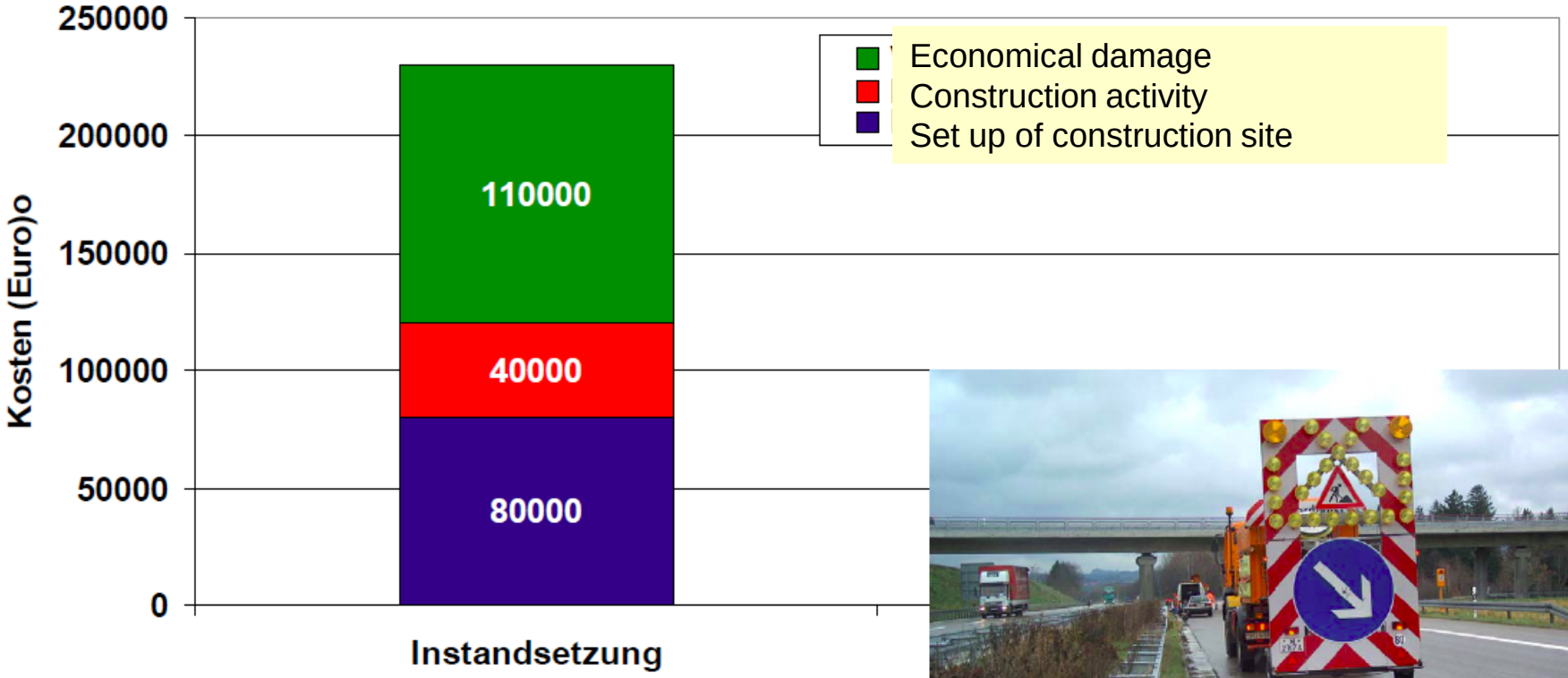
Penetration of moisture

Ingress of water leads to damage of facades



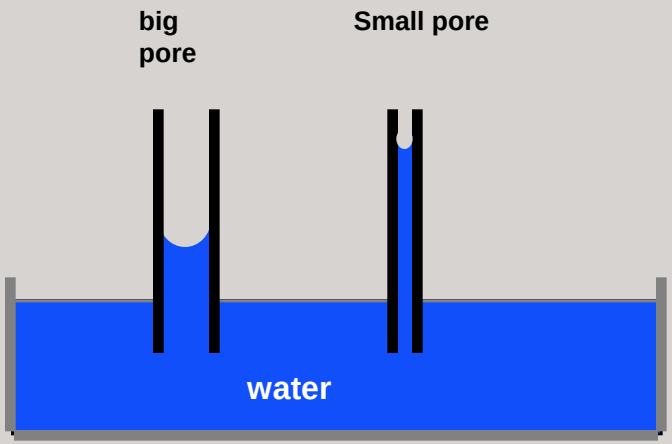
Costs for maintenance

Instandsetzung – Ökonomische Aspekte
Maintenance – economical aspects



Capillary water up-take

Water transport
due to capillary action



Speed of water up-take:

1) $v = k \times r$

k: constant
r: capillary radius

Height of water suction:

2) $h = \frac{2 \times \sigma \times \cos \Theta}{r \times \rho \times g}$

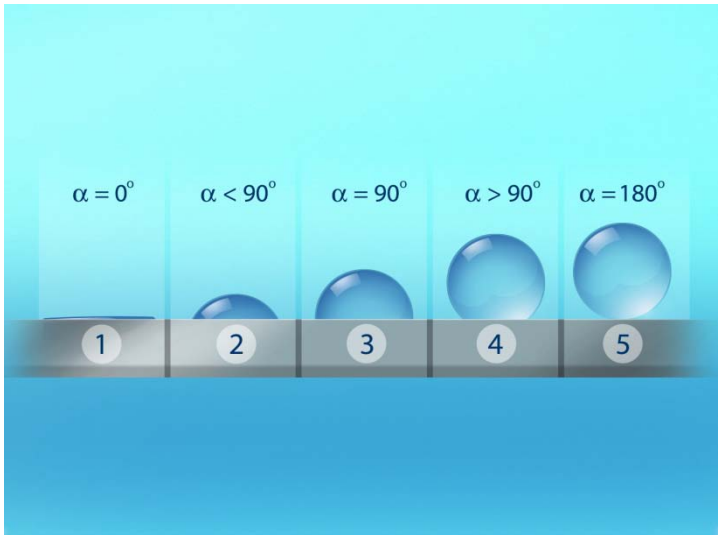
σ: surface tension
ω:: surface angle
d: density
G: gravity constant

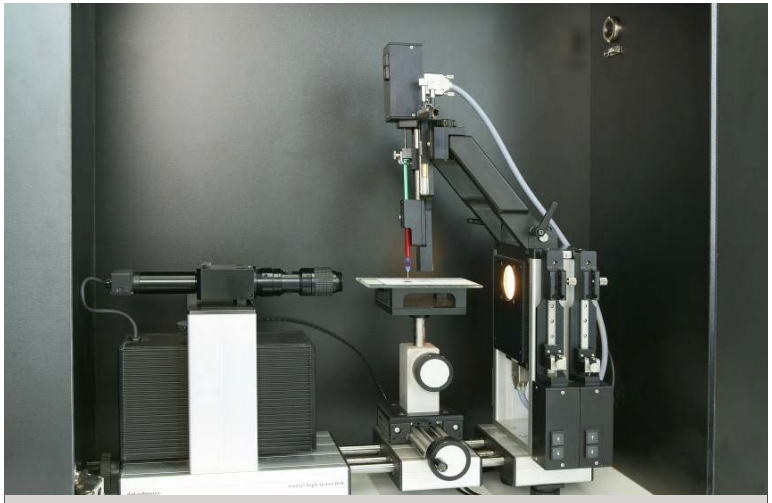
Temporal up-take:

3) $M = A \times \sqrt{t}$

M: amount of water up-take
A: water up-take coeff. $[kg/(m^2 h^{0,5})]$
t: time

Water up-take depends on surface angle





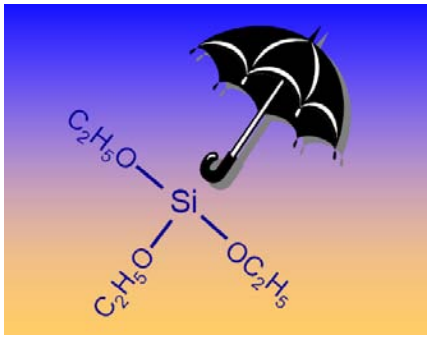
Measure of contact angle

$$2)\ h = \frac{2 \times \sigma \times \cos\Theta}{r \times \rho \times g}$$

σ: surface tension
ω:: surface angle
d: density
G: gravity constant

Solutions for water protection – hydrophobisation agents

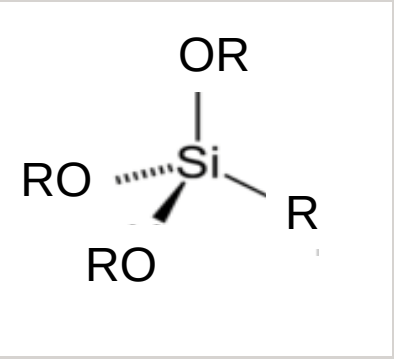
The main function of water repellents is to prevent liquid water from penetration into the building materials. To achieve long term performance water repellents need to penetrate beyond the surface layer into the interior substrate of the porous material.

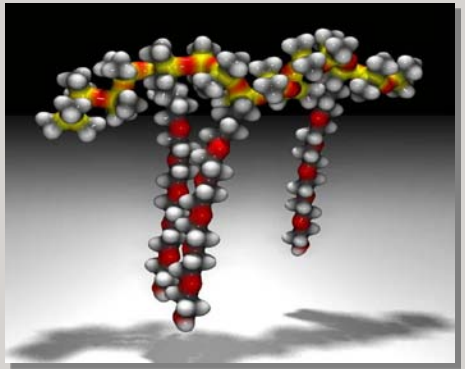


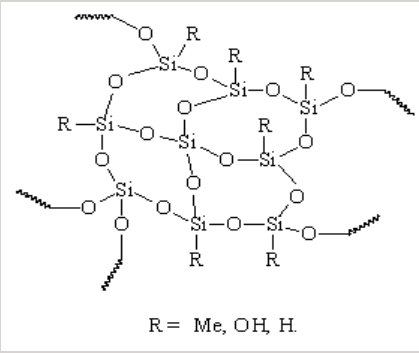
Requirements for excellent water repellent:

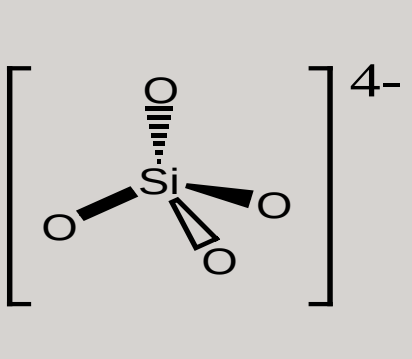
Reduction of water absorption > 70%	**No significant reduction of water vapour permeability**
Protection from driven rain	**No adverse effects on substrate**
Efflorescence control	**Easy application**
High penetration depth	**Cost effective**

Silanes, siloxanes, silicone resins









Silane

- monomeric molecules
- contain one Si
- low molecular weight
- alkyltrialkoxysilanes
- Octyl-/iso-octyl-/isobuty
- alkyl chain-length provides steric protection
- excellent impregnation depths even in alkaline substrates

Silicones

- oligomeric or polymeric molecules
- surface tension about 22 mN/m
- organo-modified siloxanes some of the methyl groups at the silicon atoms are substituted by other organic groups
- mainly used for hydrophobisation of neutral and natural substrates

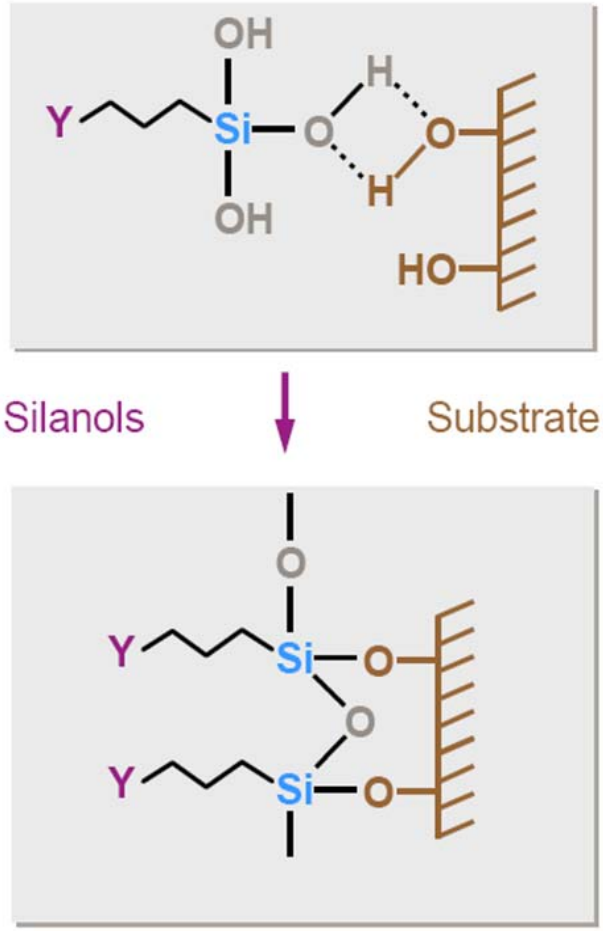
Silicone Resins

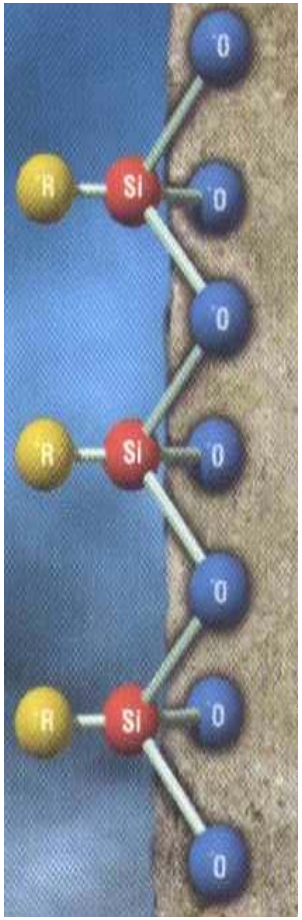
- highly branched polysiloxanes of higher molecular weight
- provide excellent beading properties
- low alkaline stability
- must be diluted to 5-10% solids

Siliconate

- e.g.. K^+ saltsod siliconates
- For concrete; injections

Mechanism of water repellence





Monomolecular spreading on surfaces

Chemical reaction with the substrate

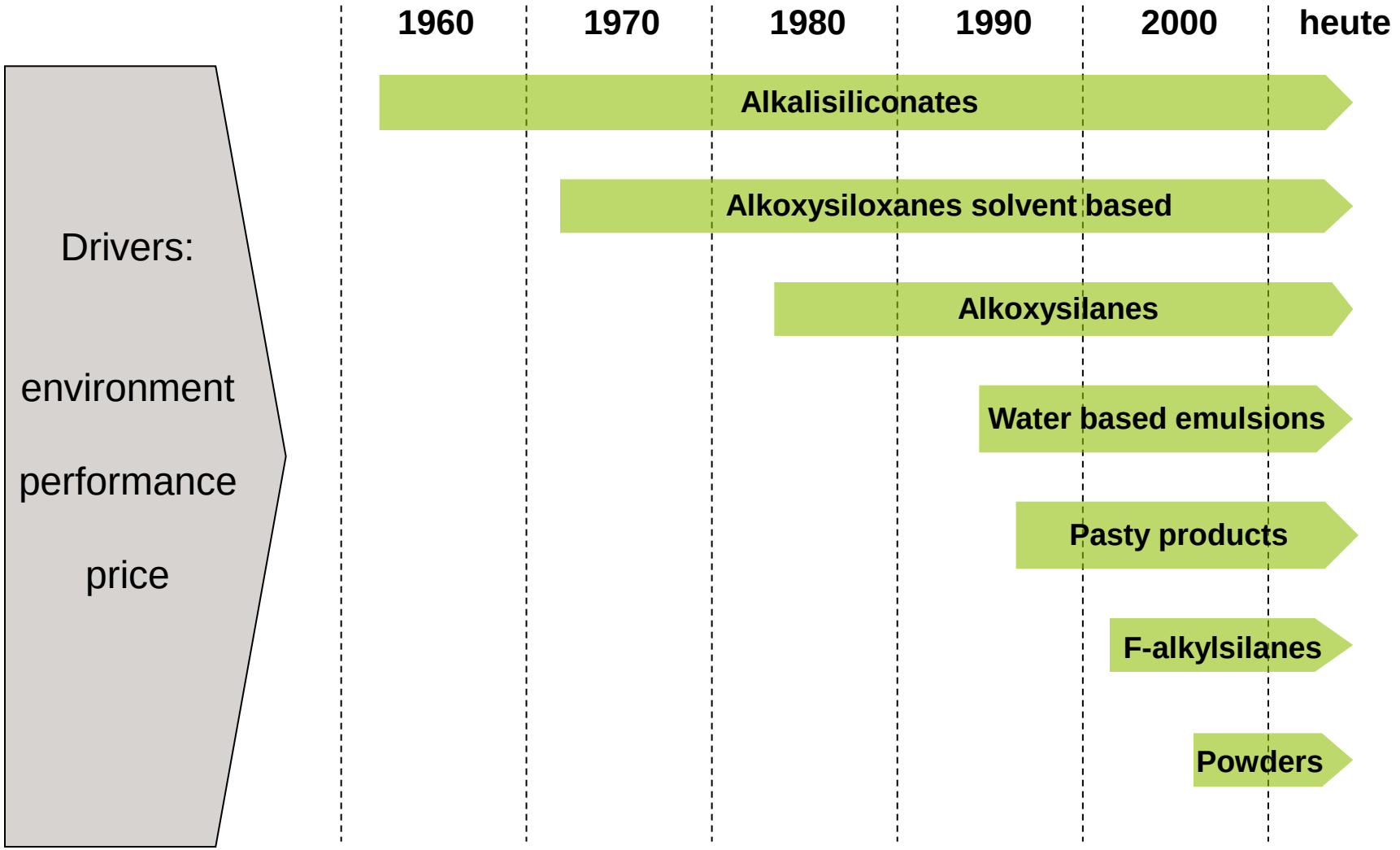
Irreversible bonding between silicone and substrate

Low surface tension

Hydrophobic

Hydrophilic

Evolution of silane- und siloxane-systems



Composition of dry-mix mortars

Raw materials for dry-mix mortars

- Cement
- Micro silica
- Hydrated lime
- Gypsum

Aggregates, fillers

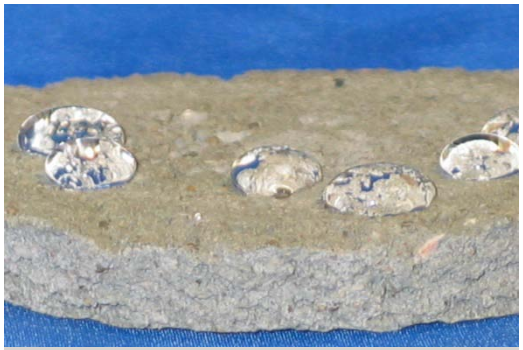
- Silica
- Limestone
- Polystyrene
- Cellulose fibre
- Polypropylene fibre

Just adding water

Additives

- Redispersible powders
- Cellulose ethers
- Pigments
- **Defoaming agents**
- Air-entraining agents
- Anti-shrinkage agents
- Plasticizing agents
- **Hydrophobing agents**

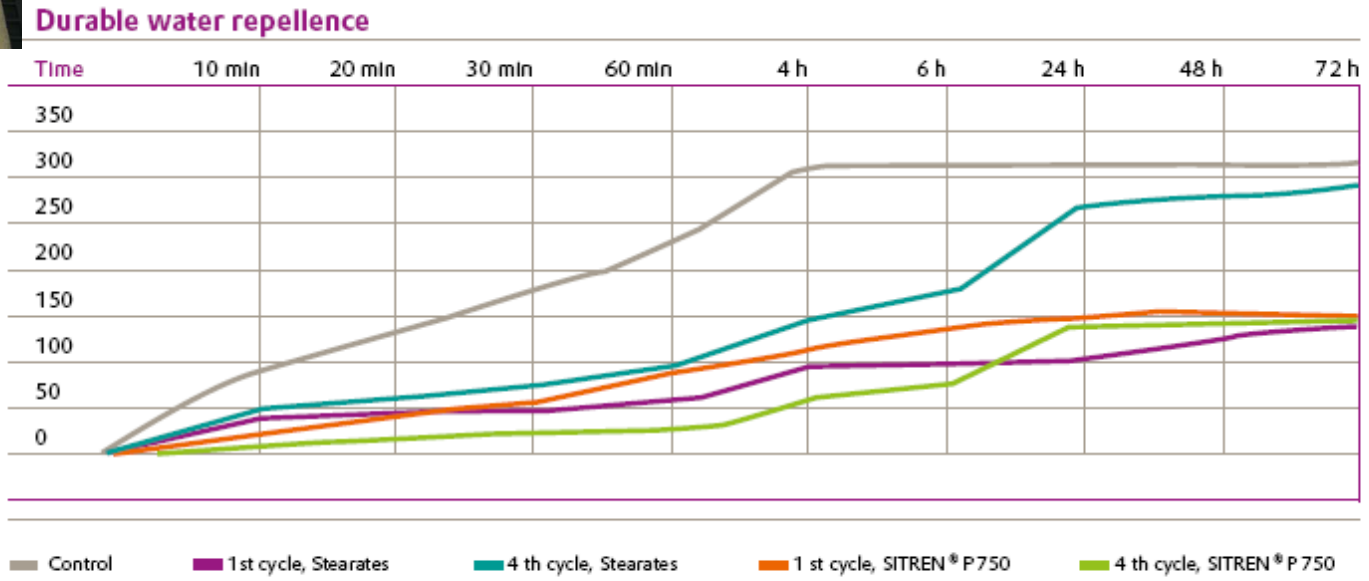
Beading test



A 0.5 ml water droplet is placed on the specimen's surface and removed after 10 minutes.
The beading effect is proportional to the wet area left by the droplet on the specimen's surface.

Water vapour permeability and breathability is not affected

Hydrocapillary Water Absorption Test UNI 10859 (DIN 52617)

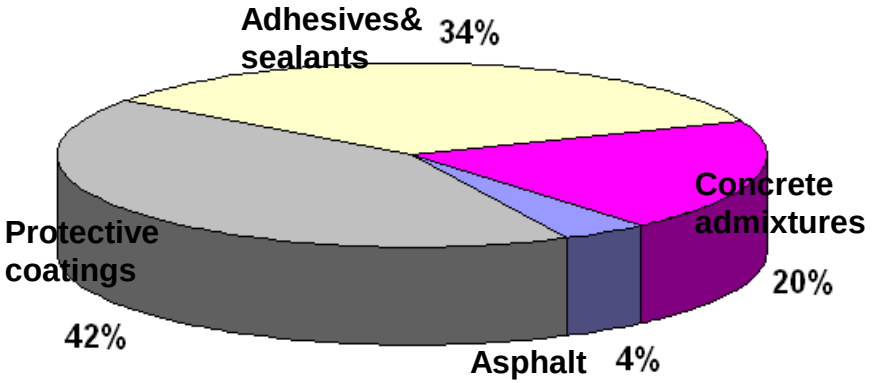


Water up-take [mg/cm²] in tile grout formulation according to UNI 10859 (similar to DIN 52617).

Applications of silicones in construction

1 Additive for silicate paints
2 Insulation material
3 Matrices for concrete
4 Concrete hydrophobisation
5 Primer for paints
6 Sanitary grouts
7 Gas concrete hydrophobisation
8 Brick hydrophobisation
9 Gypsum hydrophobisation
10 Profile seals
11 Rubber seals
12 Structural glazin
Roofing tileshydrophobisation
Window profiles
13 Expansion joints
14 Natural stone hydrophobisation
15 Limestone hydrophobisation
16 Binder systems for silicate paints
17 Additives for renders
18 Damp proof course

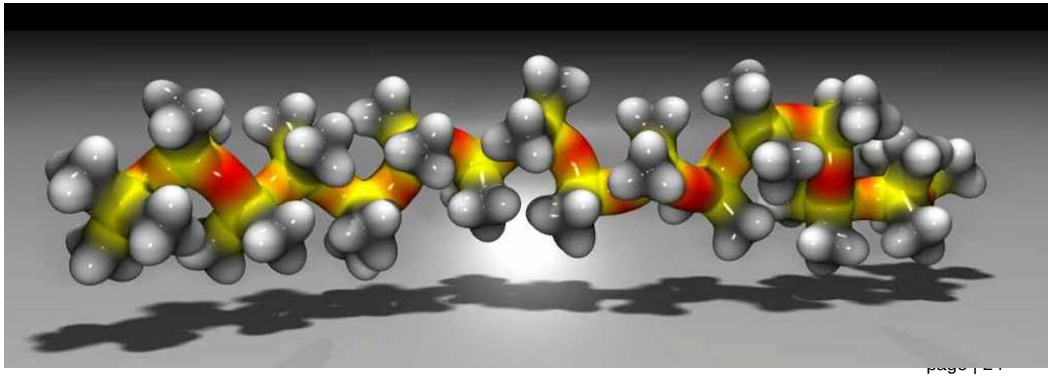
Sustainable protection by silicones in construction



17,9 Billion €
Total Construction Market

Conclusions

- There is a strong relation between building physics and climate
- Intensive R&D for new construction materials inclusive binders additives to improve durability and sustainability
- Silicones and their modifications offer due their unique properties protection as water repellents for constructions and buildings right from the beginning



Thank you for your attention

Do you have questions ???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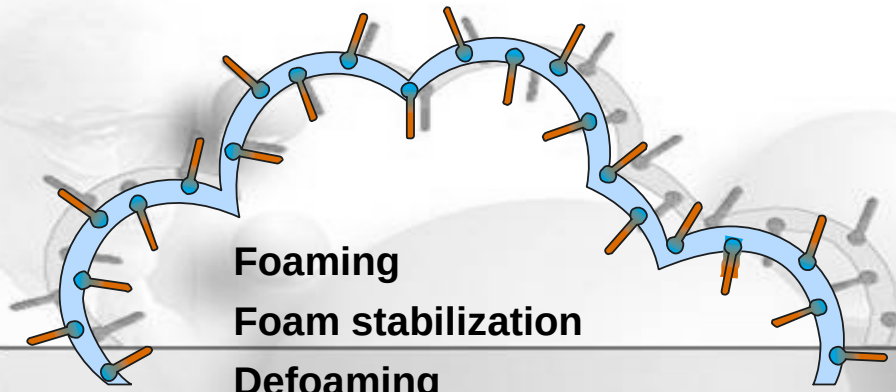
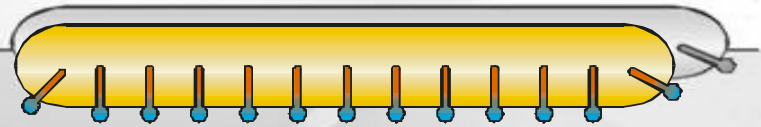
Consumer Specialties addresses a broad variety of phenomena at interfaces.



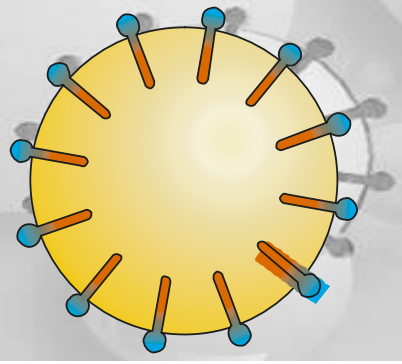
Foaming
Foam stabilization
Defoaming

Softening
Bleaching
(Re)-Freshing

Wetting
Spreading
Washing
Cleaning
Polishing
Disinfecting
Anti-shrinkage



Releasing
Hydrophobising
Hydrophilising
Lubricating
Adhering
Conditioning



Emulsifying
Solubilising
Dispersing
Coagulating
Controlling rheology

Hydrocapillary Water Absorption Test

Preparation of Test Specimen :

The dry mix formulation of Wall Putty (without any additive) was taken as substrate for the comparative study.

Different cubes (4 cm x 4cm x 16 cm) of wall putty were prepared by incorporating separately Sitren P 750 and competition product at 0.1, 0.2 & 0.3 % concentrations each along with a control.

Curing : The cubes were allowed to set at 100 % humidity at room temperature for 24 hours and then cured for 31 days at temperature 23°C and 50 % relative humidity.

After curing for 31 days, Hydrocapillary Water Absorption Test was performed on the cubes.

Hydrocapillary Water Absorption Test :

The test specimen were kept on a water saturated polyurethane soft foam (density 25-30 g/l). The water absorption is determined in kg/m² by weighing the specimen after 10 min, 20 min, 30 min, 60 min, 4 h, 6 h, 24 h, 48 h, 72 h.