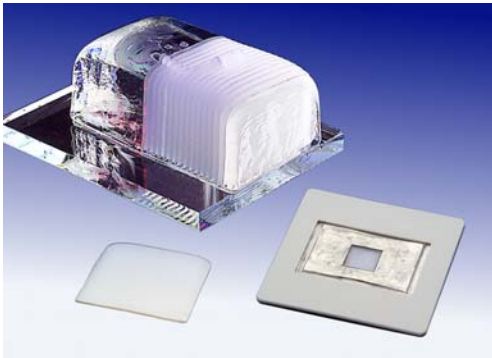


Early warning dosimeters for monitoring indoor museum climate: Environmental Impact Sensors and LightCheck™



Dr. Peter Mottner
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Bronnbach Branch



D - 97877 Wertheim, Germany



Content

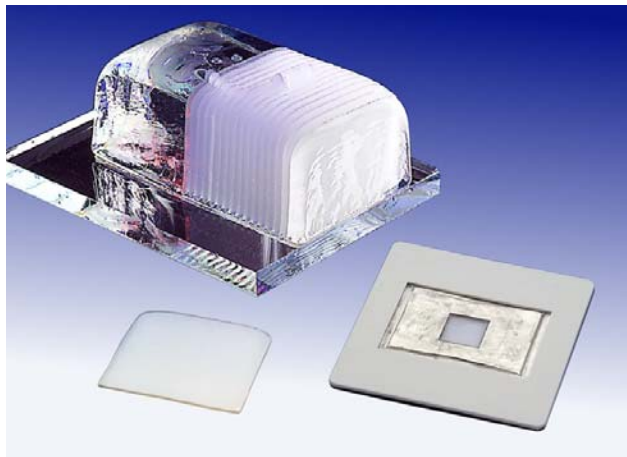
Background, method and application of:

Glass sensor / Environmental sensor Light dosimeter

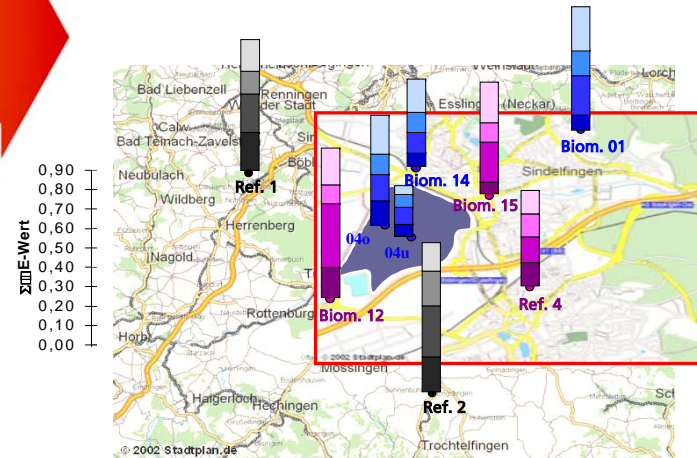


Environmental Impact (Glass) Sensor

Early warning system: Method



Assessment of the environmental impact



atmospherical impact



risk evaluation

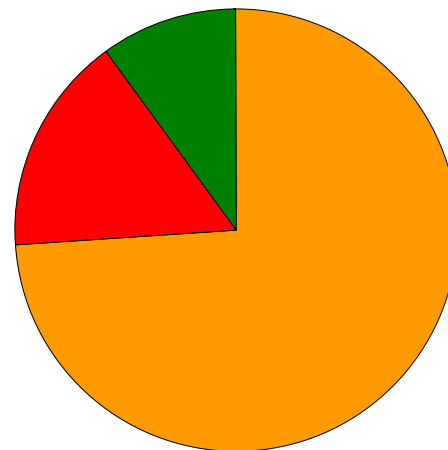
Indoor/outdoor climate assessment: museums, churches, show cases
Assessment of production plants: e.g. DaimlerChrysler

Environmental Impact (Glass) Sensor: Glass Composition

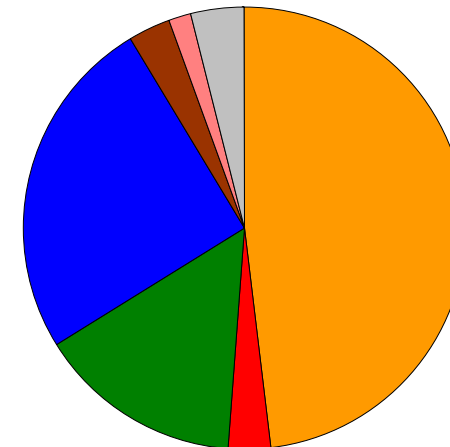
German Technical Guideline VDI 3955/2: Assessment of the corrosive effects of complex environmental conditions at materials: exposure of glass sensors

Exposure time: 3 to 12 months

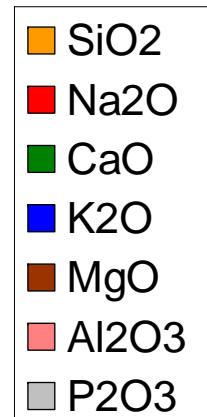
Sensor material:
Highly sensitive to
corrosion
(Mass-%)



Modern Glass



Glass Sensor MI



Environmental Impact (Glass) Sensor

Early warning system: Method

Assessment of the environmental impact

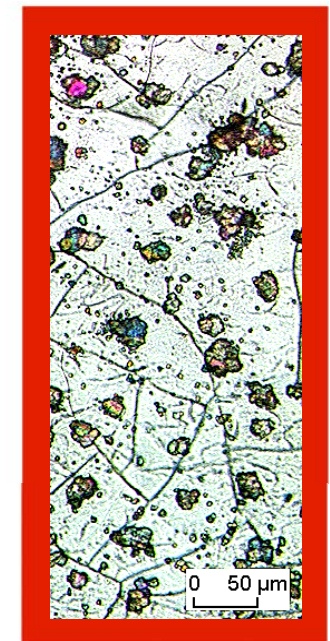
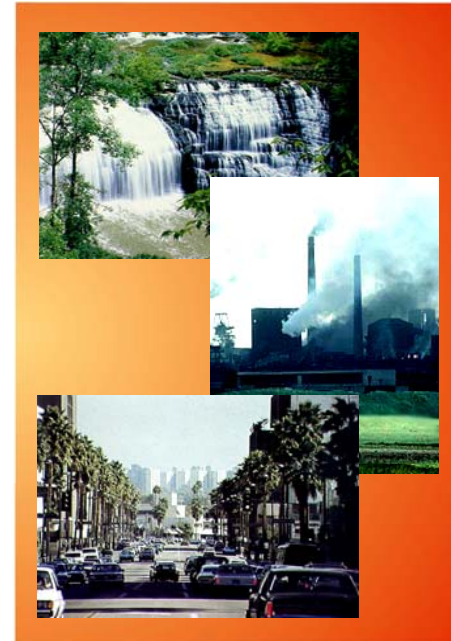
Clients:

Object curators
(e.g. Museums, Cathedrals)

Industry
(e.g. DaimlerChrysler)



Glass surface before exposure



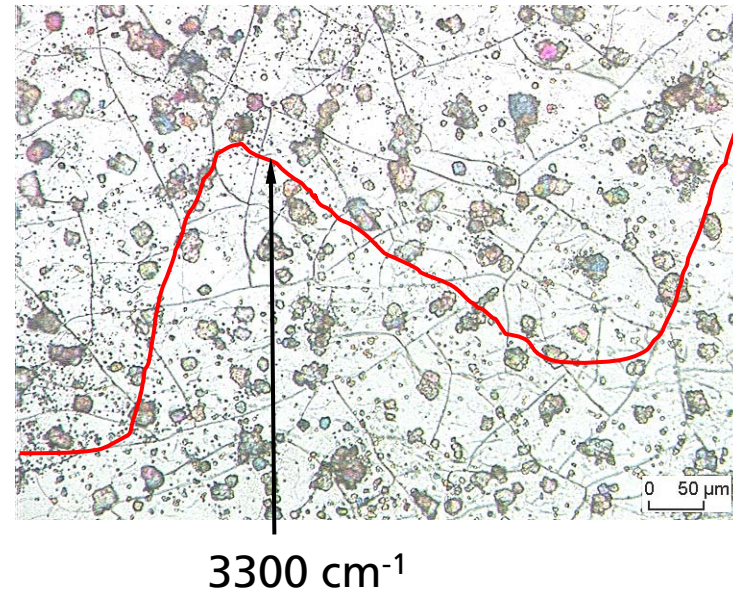
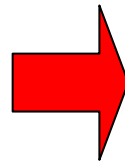
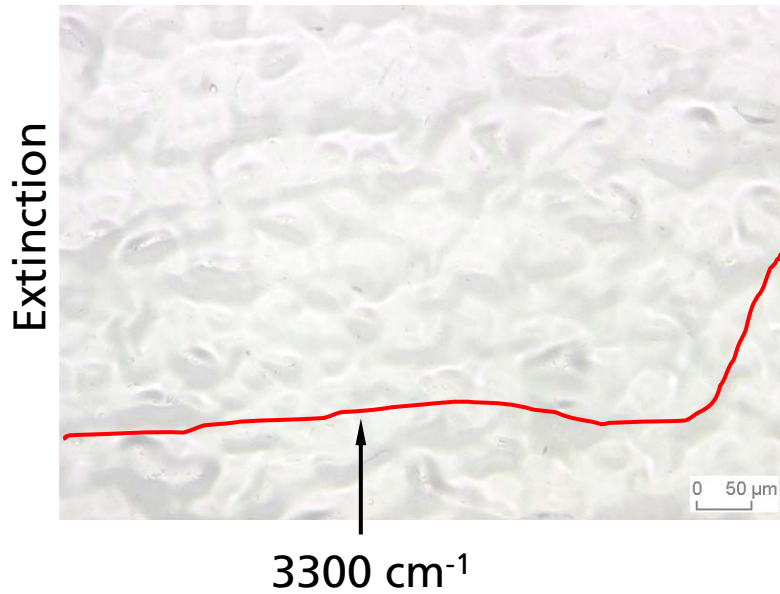
Glass surface after 3 months exposure outdoors

Environmental Impact (Glass) Sensor Evaluation

Extinction:
 $\Delta E\text{-value} = 0 < \Delta E < 1$

IR measurement (transmission mode) of H₂O /OH-band before exposure

corrosion crystals
gel layer formation
cracks
after exposure

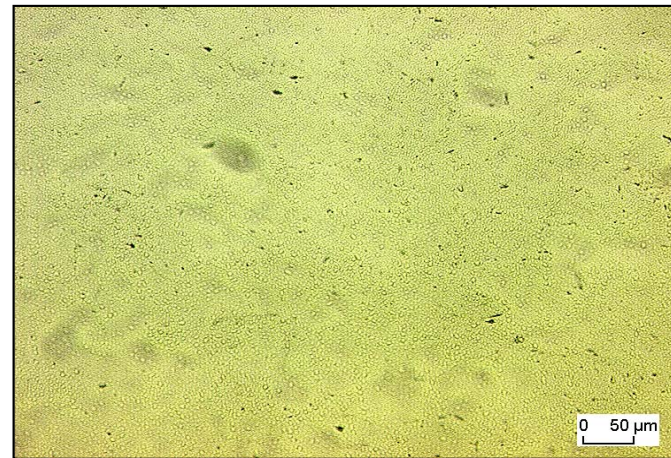


Environmental Impact (Glass) Sensor Monitoring / Measurement

1. Example: Römisch-Germanisches Museum, Cologne

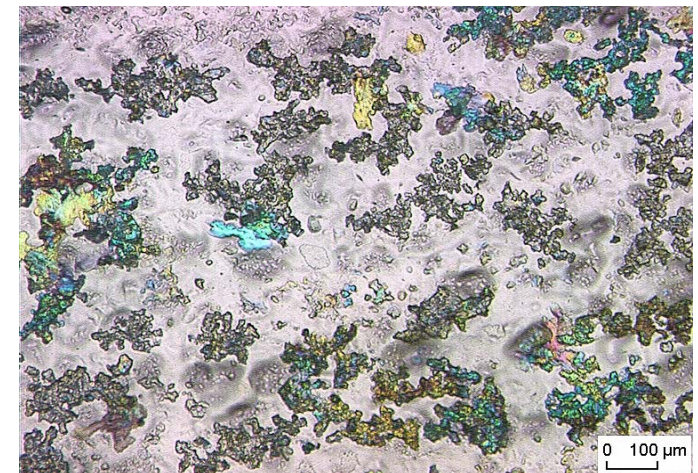


Sensor surface
(Light microscopy)



Minor damage

3 Month exposure time

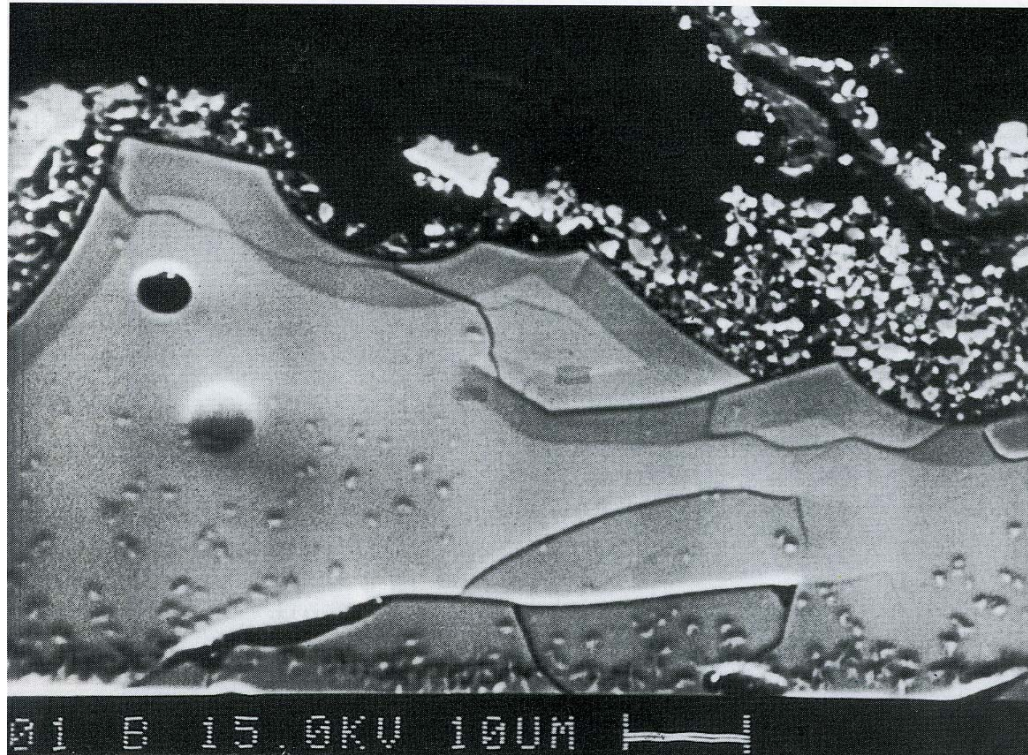
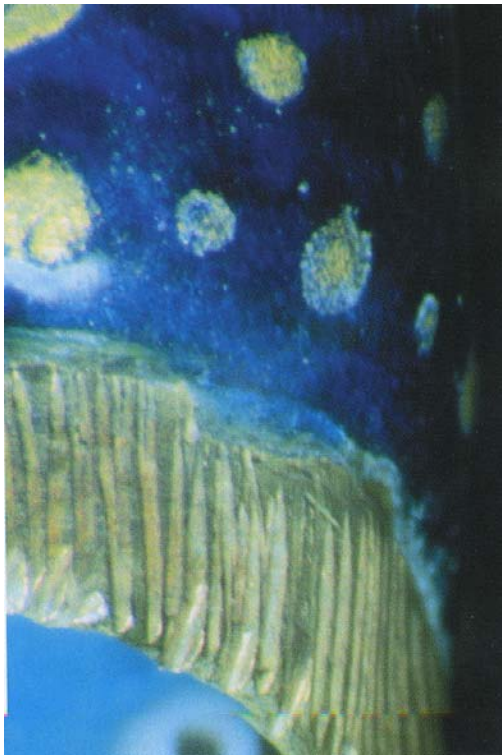


Surface corrosion

2. Example: Enamel Artworks Green Vault Dresden Damage



Enamel Artworks Green Vault Dresden Instrumental Analysis: Microscopy/SEM

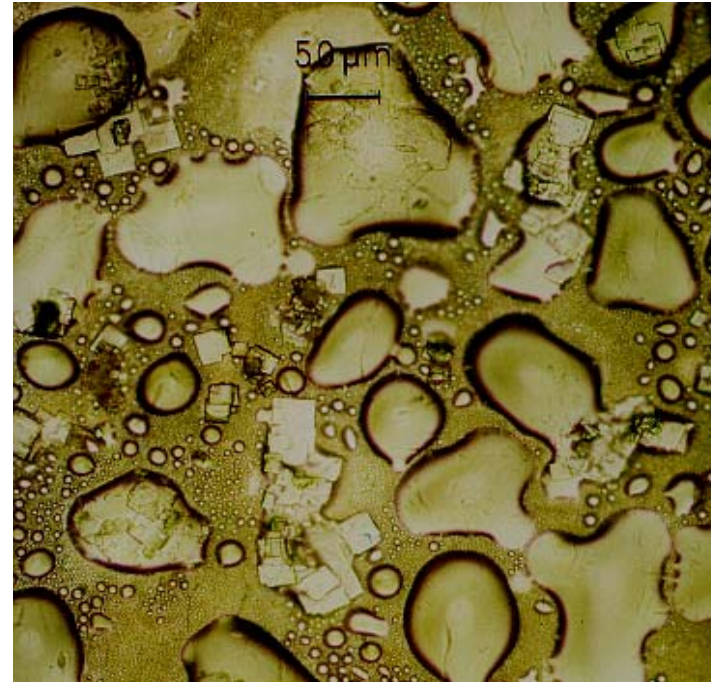


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Environmental Impact (Glass) Sensors Monitoring/Measurement Enamel Artworks Green Vault Dresden



Showcase „Hofstaat Großmogul“

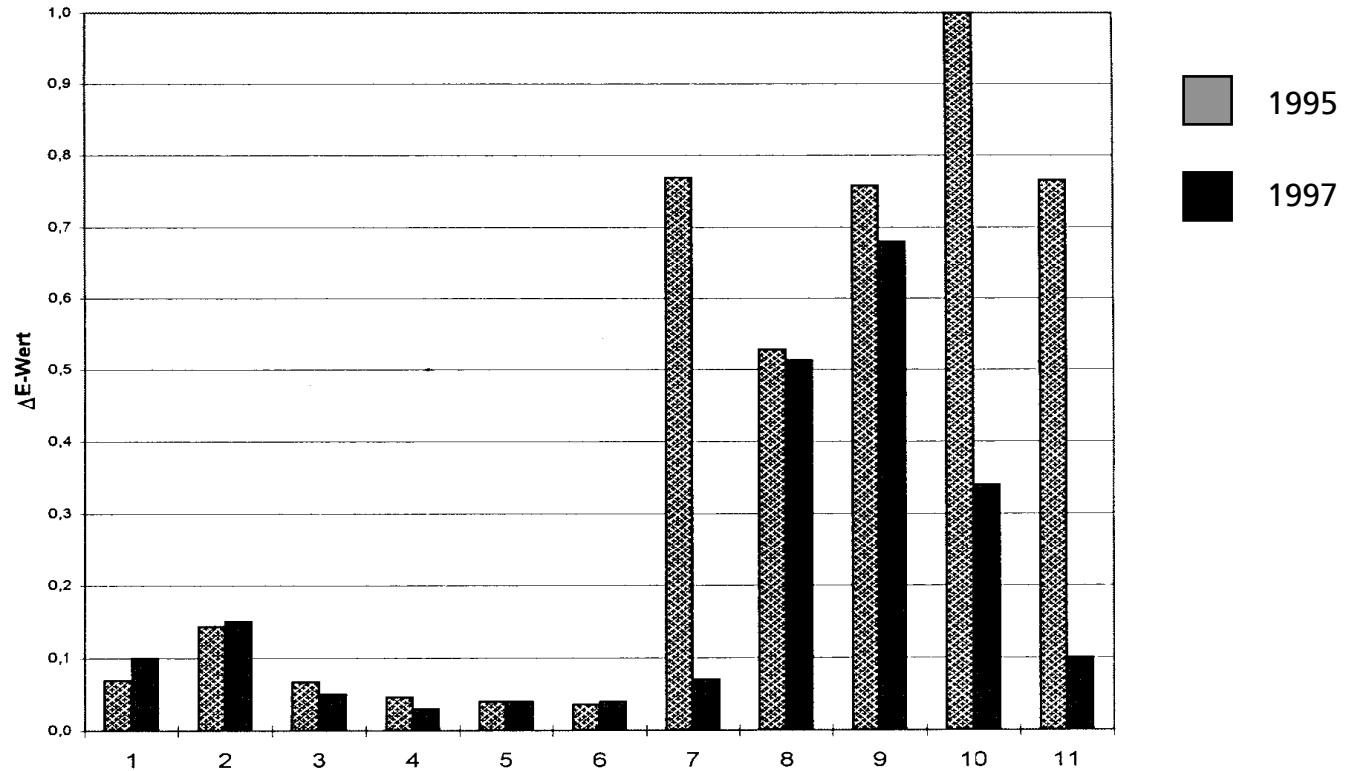


Sensor surface (light microscopy):
wet corrosion crystals

Environmental Impact (Glass) Sensors: Measurements Green Vault Dresden Results (ΔE -value)

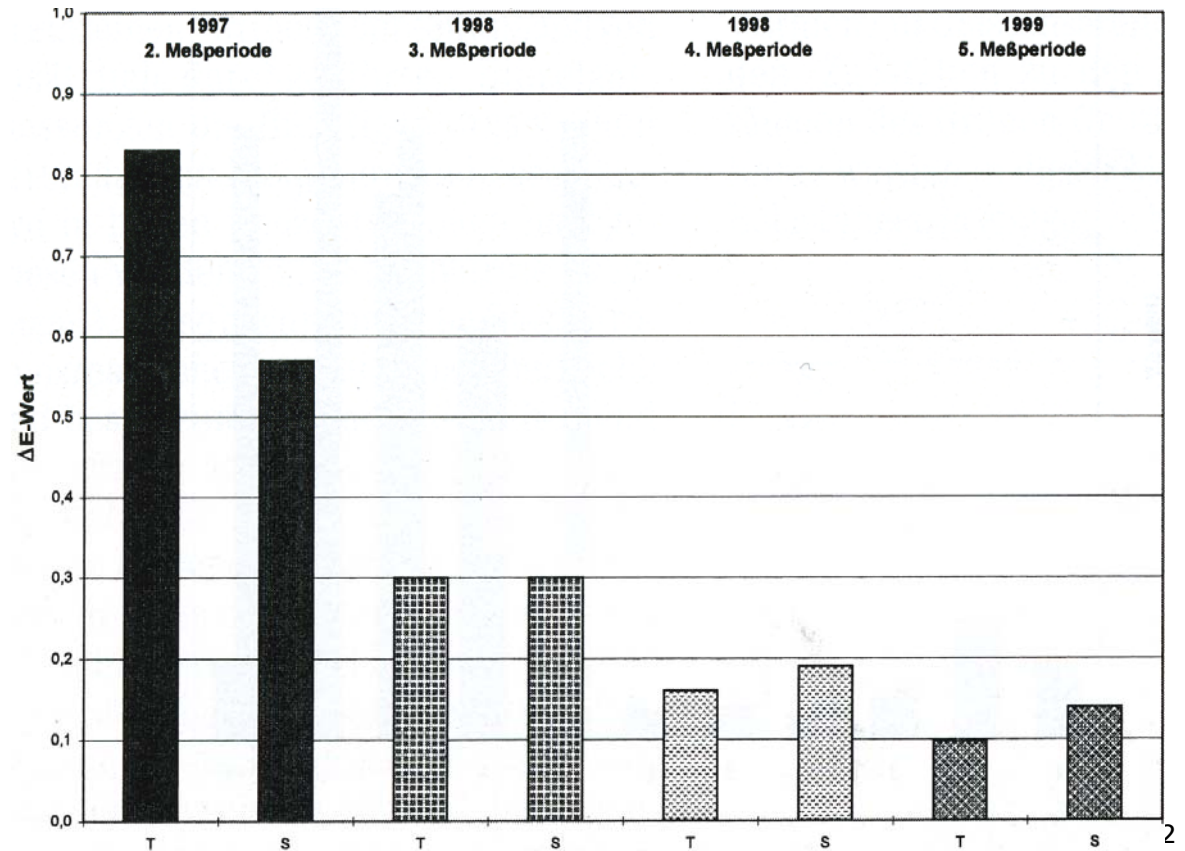
Exposure time 6 months

- 1 = building facade
- 2 = air condition
- 3 = exhibition hall „gelber Raum“
- 4 = exhibition hall „roter Raum“
- 5 = showcase „Lebensalter“
- 6 = showcase „Silberwand“
- 7 = showcase „Kirschenvitrine“
- 8 = showcase „Großmogul“
- 9 = showcase „Kaffeezeug“
- 10 = showcase „diverse Schalen“
- 11 = showcase „Serpentin“



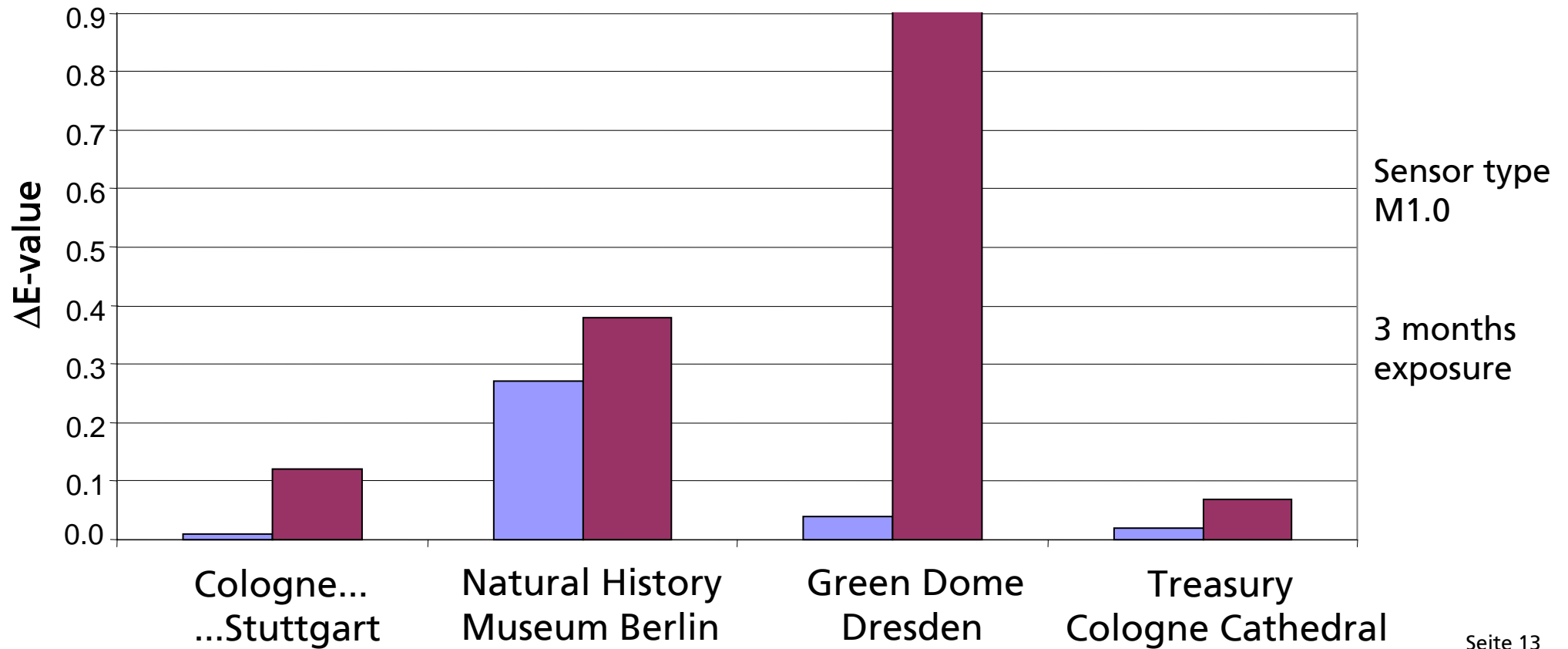
Environmental Impact (Glass) Sensors: Measurements Green Vault Dresden Development of Air Quality after Interventions (Show Case "Großmogul")

Exposure time 3 months

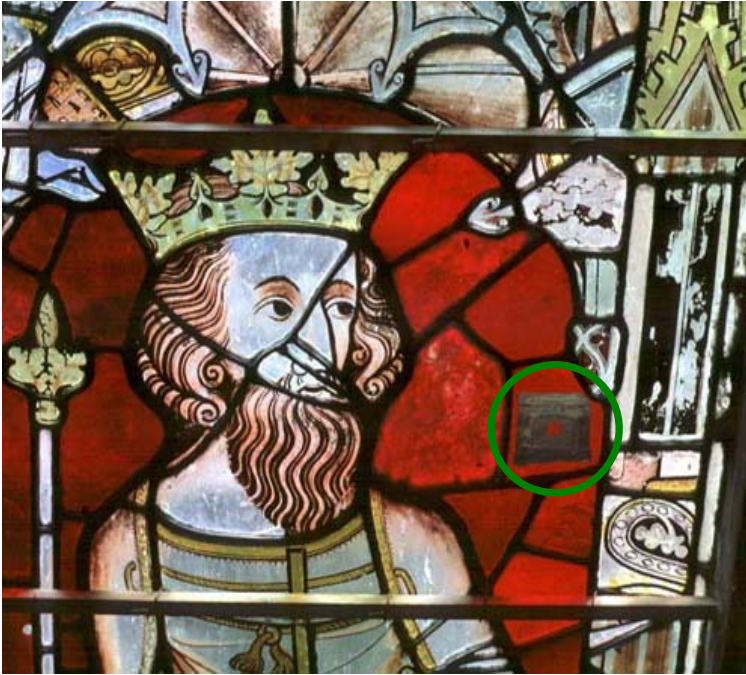


Environmental Impact (Glass) Sensors: Various sites

Overview of results from various studies (min / max values from different exposure sites)



Environmental Impact (Glass) Sensor Campaigns / Overview



Glass sensor Gloucester

Evaluation of protective glazings:

e.g. in York, Canterbury, Leon, Assisi, Cologne, Erfurt, Long Melford, Lichfield, Frankfurt/Oder

Evaluation of museum indoor climate, evaluation of showcases:

e.g. in London, Dresden, Coburg, Würzburg, Vienna, Geneve, Stuttgart, Berlin

Outdoor measurements:

e.g. Brandenburger Tor (Berlin),

World-wide studies for industrial clients

Light dosimeter LightCheck™

EC-Project Lido (2001 - 2004): A light dosimeter for monitoring cultural heritage: development, testing and transfer to market

- development of a light dosimeter: sensitive blue dye, polymer matrix, glass as substrate
- characterisation of the fading in the climate chamber and on site
- standardisation of light dosimeters as early-warning-system for museums and historic houses: LightCheck™



A project funded by the EC (EVK4-CT-2000-00016)

Seite 15

Light dosimeter LightCheck™ Testing

Exposure campaigns in different museums to study the influence of:

natural / artificial light

climatic and geographic varieties

building features

local needs of end-users



Seite 16

Light dosimeter LightCheck™

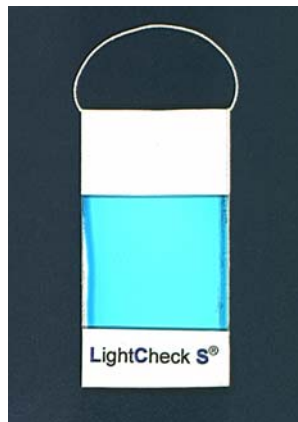
Two approaches for different systems

LightCheck® Sensitive (LCS)

colour: blue dye

matrix: heteropolysiloxane

substrate: glass

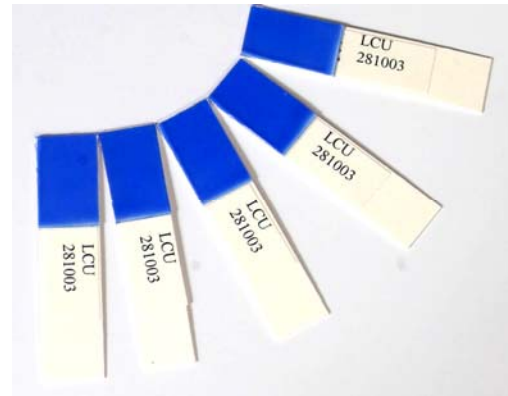


LightCheck® Ultra (LCU)

colour: blue and red dye

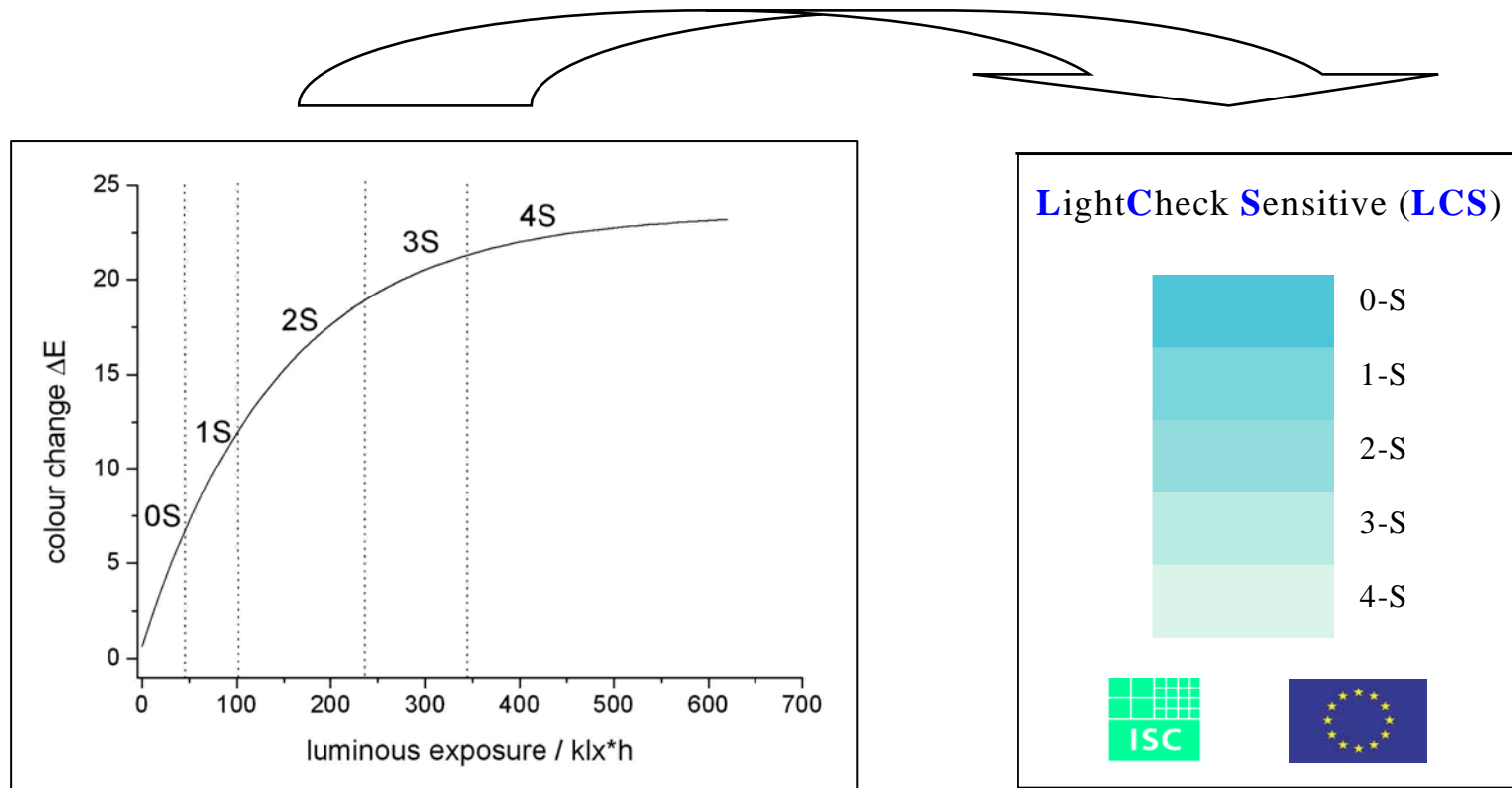
matrix: organic polymer (PVAc)

substrate: PE coated paper



Light dosimeter LightCheck™

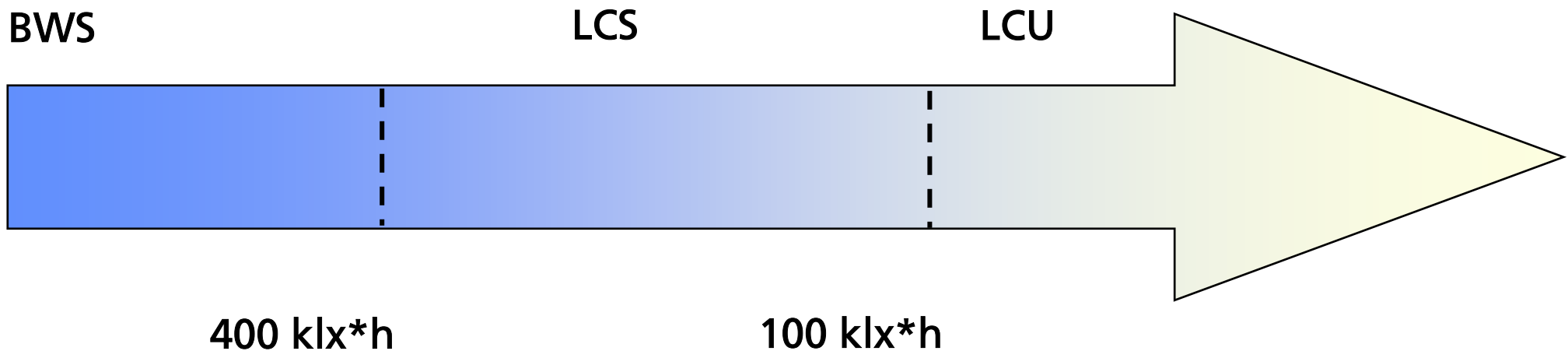
From the laboratory to museum practice: the colour reference scale



Light dosimeter LightCheck™

Two approaches for different fields of application

Range of sensitivity



Light dosimeter LightCheck™ Transfer to market

From laboratory experiments to large-scale production

EC-award:

Pan-European

Grand Prix d'Innovation

Monaco, 2003

(Cultural Heritage Preservation)



Reference

Environmental (Impact) Glass Sensors
for indoor / outdoor exposure
(museums, show cases, buildings,
churches / protective glazings)

For **Lightcheck** order:

www.lightcheck.co.uk

(Particle Technology, UK)

can be ordered by:

Fraunhofer Institute for Silicate Research (ISC)

Competence Team "Environmental Monitoring and Conservation Research"

Bronnbach Branch

D-97877 Wertheim-Bronnbach, Germany

Dr. Peter Mottner

E-mail: peter.mottner@isc.fhg.de

Phone: +49(0)9342 9221-711 (-701) ; Fax: +49(0) 9342 9221-799

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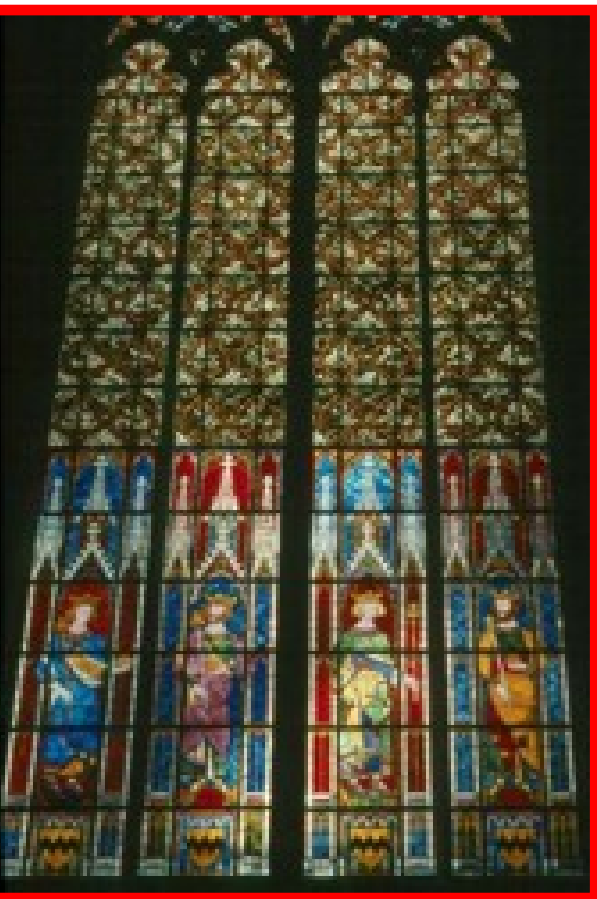
Sustaining Europe's Cultural Heritage: From Research to Policy
London, 02 September 2004

VIDRIO



**DETERMINATION OF CONDITIONS TO PREVENT WEATHERING
DUE TO CONDENSATION, PARTICLE DEPOSITION AND
MICRO-ORGANISM GROWTH ON ANCIENT
STAINED GLASS WINDOWS WITH PROTECTIVE GLAZING**

Contract n. EVK4-CT-2001-00045
Starting Date: 1st February 2002



COORDINATOR

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Dr. Pawel Karaszewicz



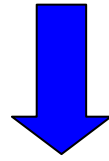
Mrs. Gerlinde Möhrle



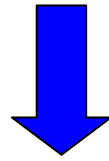
Dr. Sebastian Strobl



Medieval stained glass windows find their glory in their original setting



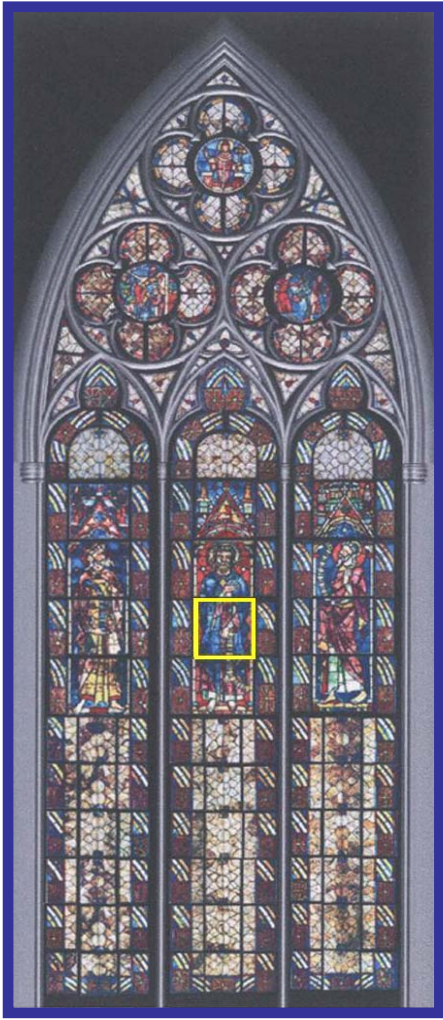
Due to environmental attack



Risk of heavy damage



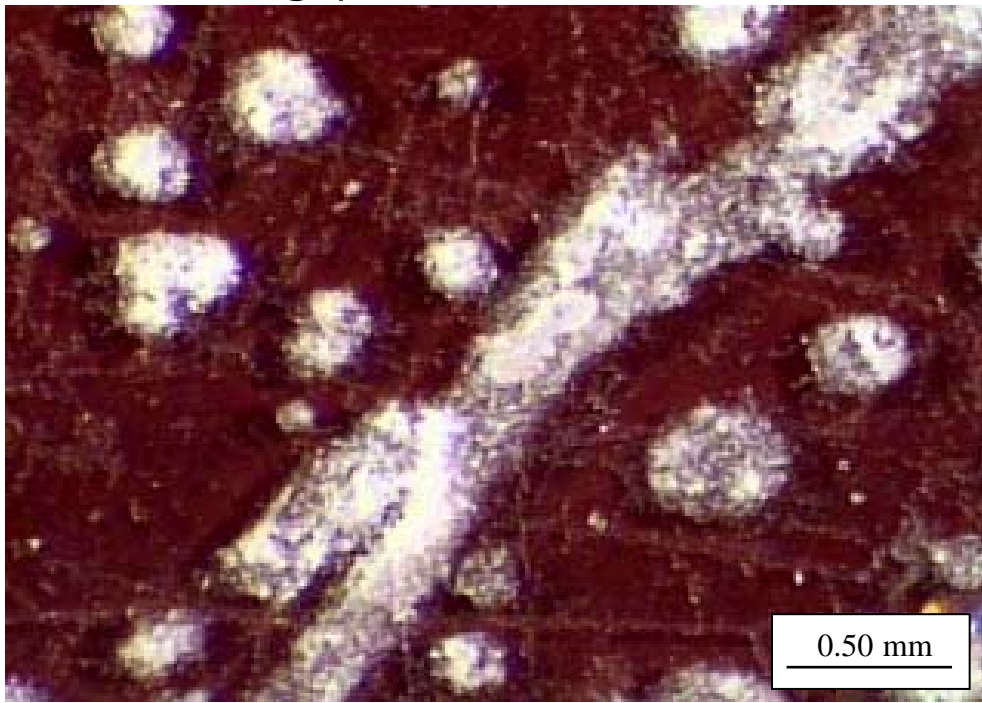
Microscope view of glass surface attacked by air pollution



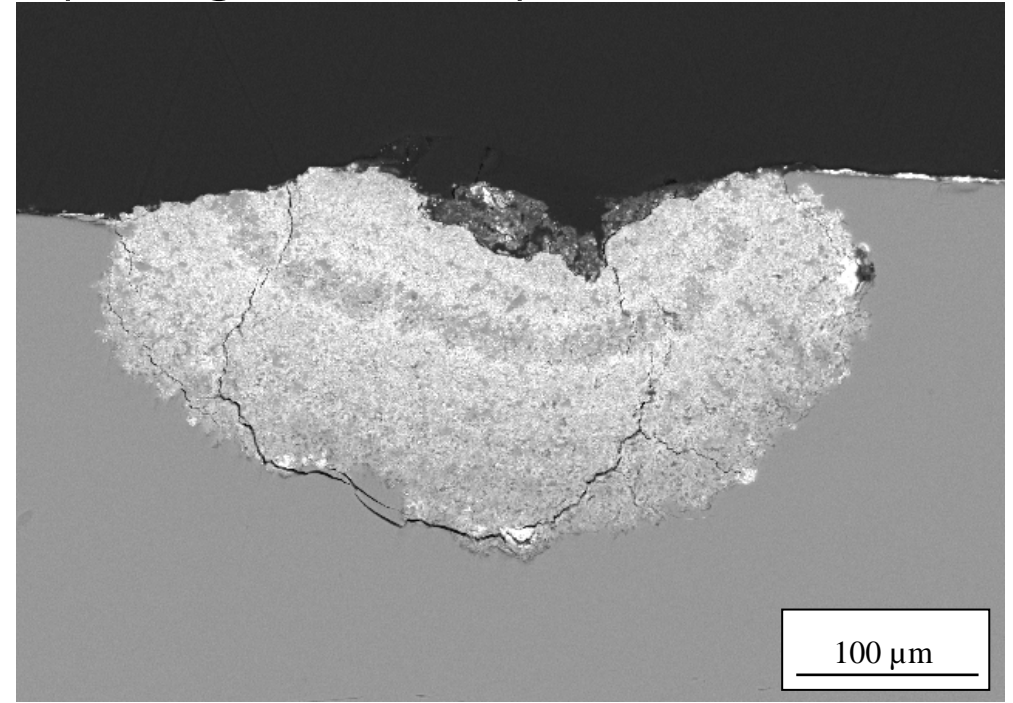
Example for weathering phenomena on medieval stained glass: Analysis of glass by LM and SEM

Original glass fragment

Weathering phenomena: micro-cracks, pitting, white deposits



LM surface

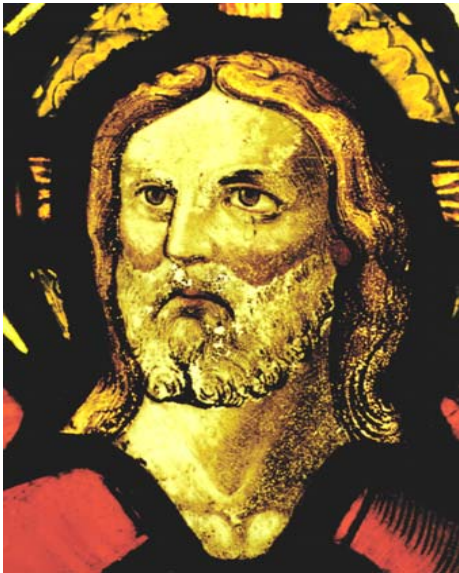


SEM, cross section

The atmospheric attack depends on:

Microclimatic conditions (cycles of T, RH, condensation, etc.)

➔ cracks, activation of corrosion, biological activity, etc.



Biolayer on glass

- **Deposition of aerosol particles and potentially harmful compounds**

(soot, organic particles, S-rich or Fe-rich particles, $(\text{NH}_4)_2\text{SO}_4$, CaSO_4)

➔ soiling and visual degradation

- **Chemical reactions** (e.g. H_2SO_4)

➔ accelerated corrosion

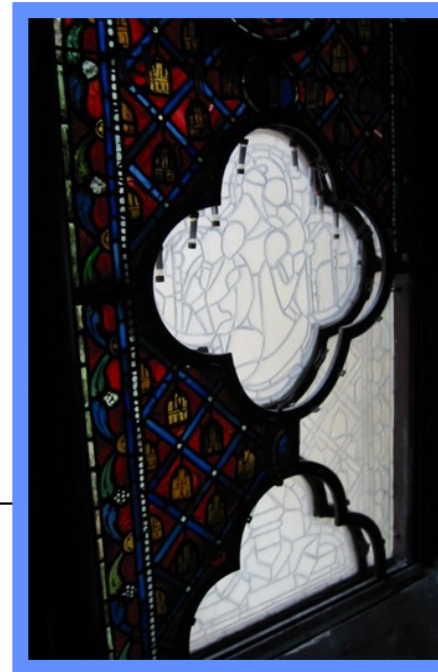
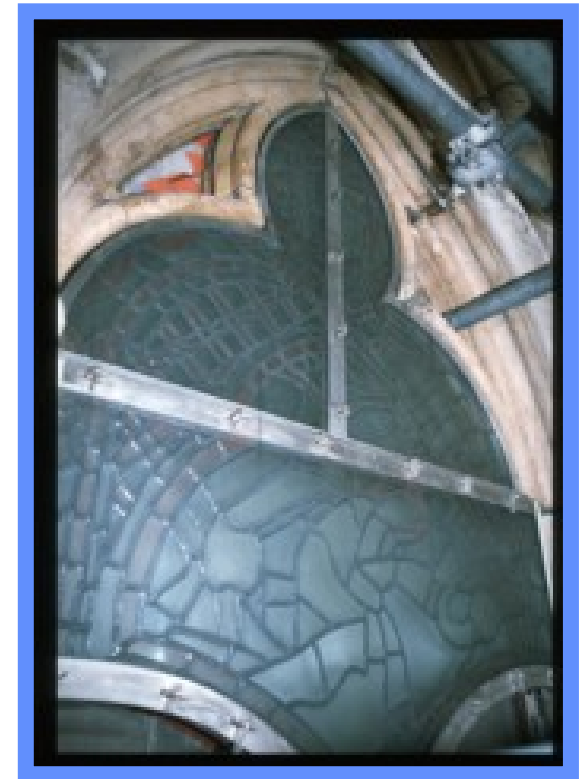
- **Biological attack**

➔ formation of biolayers, biopitting, etc

Protective glazing: effective protection with a new shield of glass?



Outer surface of the protective glazing in Saint Urbain Basilica, Troyes-France



Outer and inner surface of protective glazing in Sainte Chapelle, Paris - France

Monuments subjects of the study

In France: *Saint Urbain Basilica – Troyes*

(rural environment)



and

Sainte Chapelle – Paris

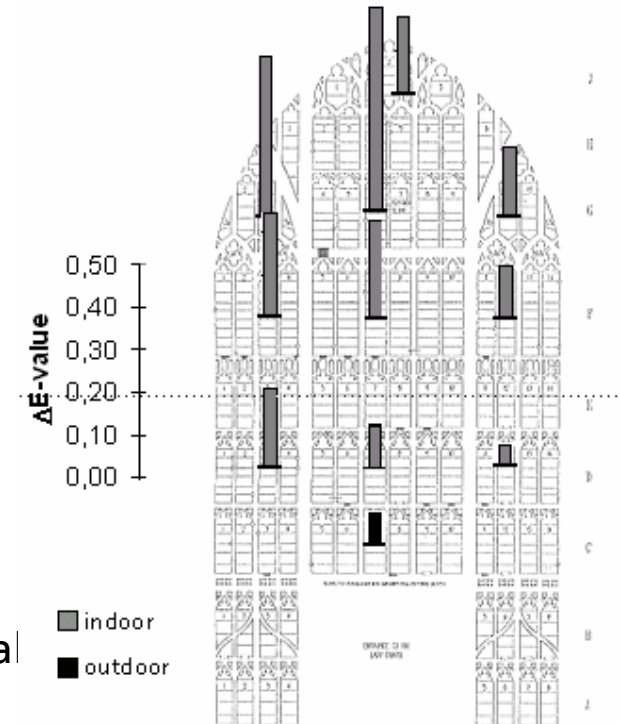
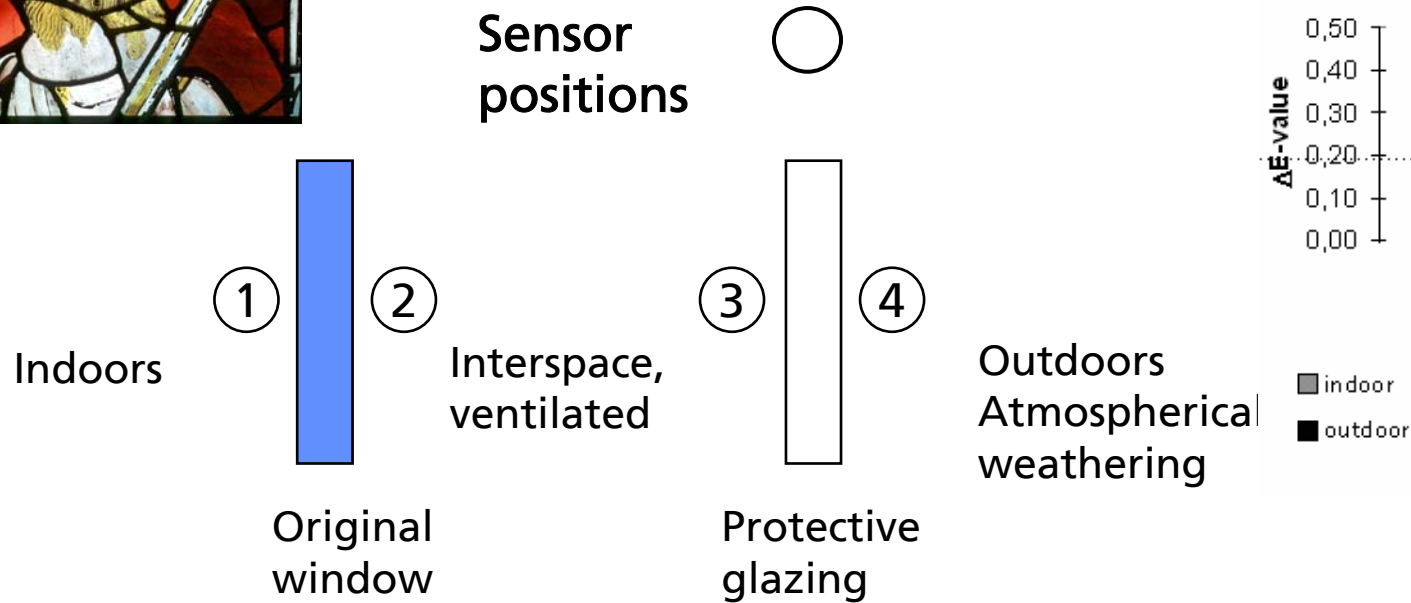
(urban environment)

In Germany:

Cologne Cathedral



Environmental Impact (Glass) Sensor Measurements: Troyes



Environmental Impact (Glass) Sensor Measurements Troyes: Results (ΔE)

