Indoor air quality within museum showcases

Alexandra Schieweck
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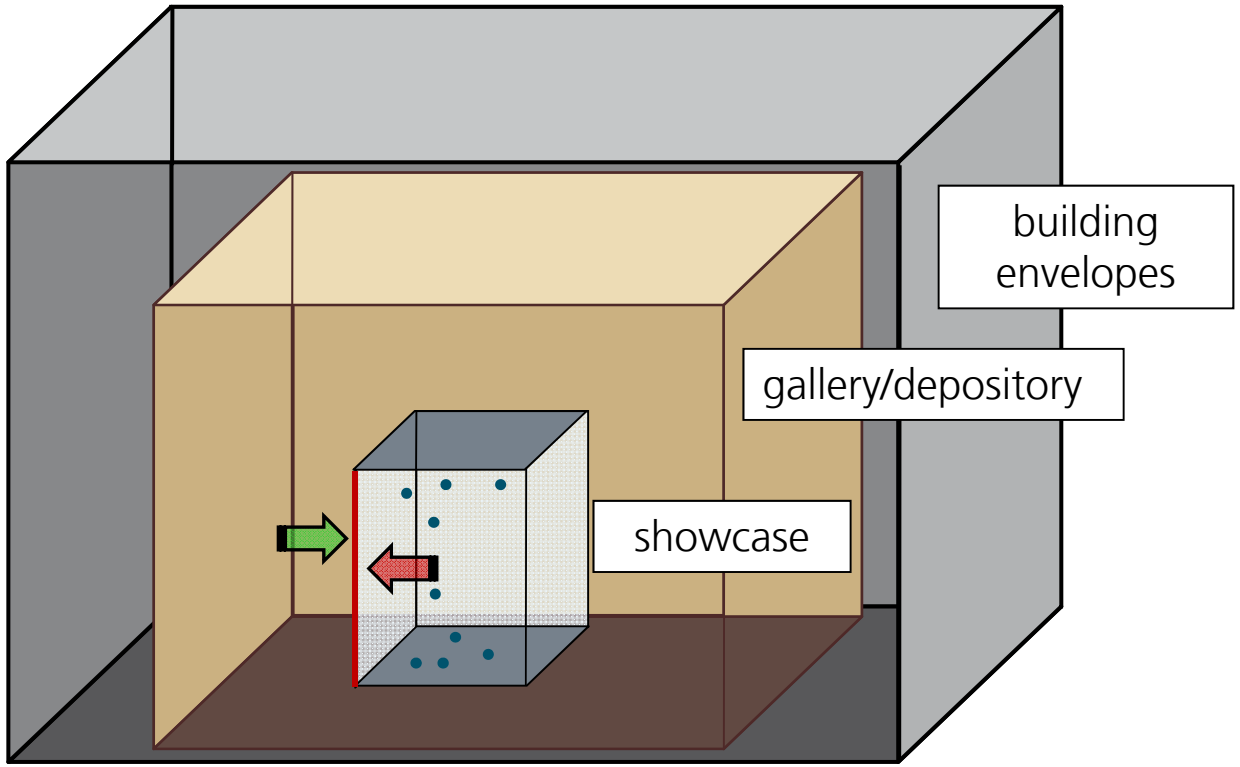
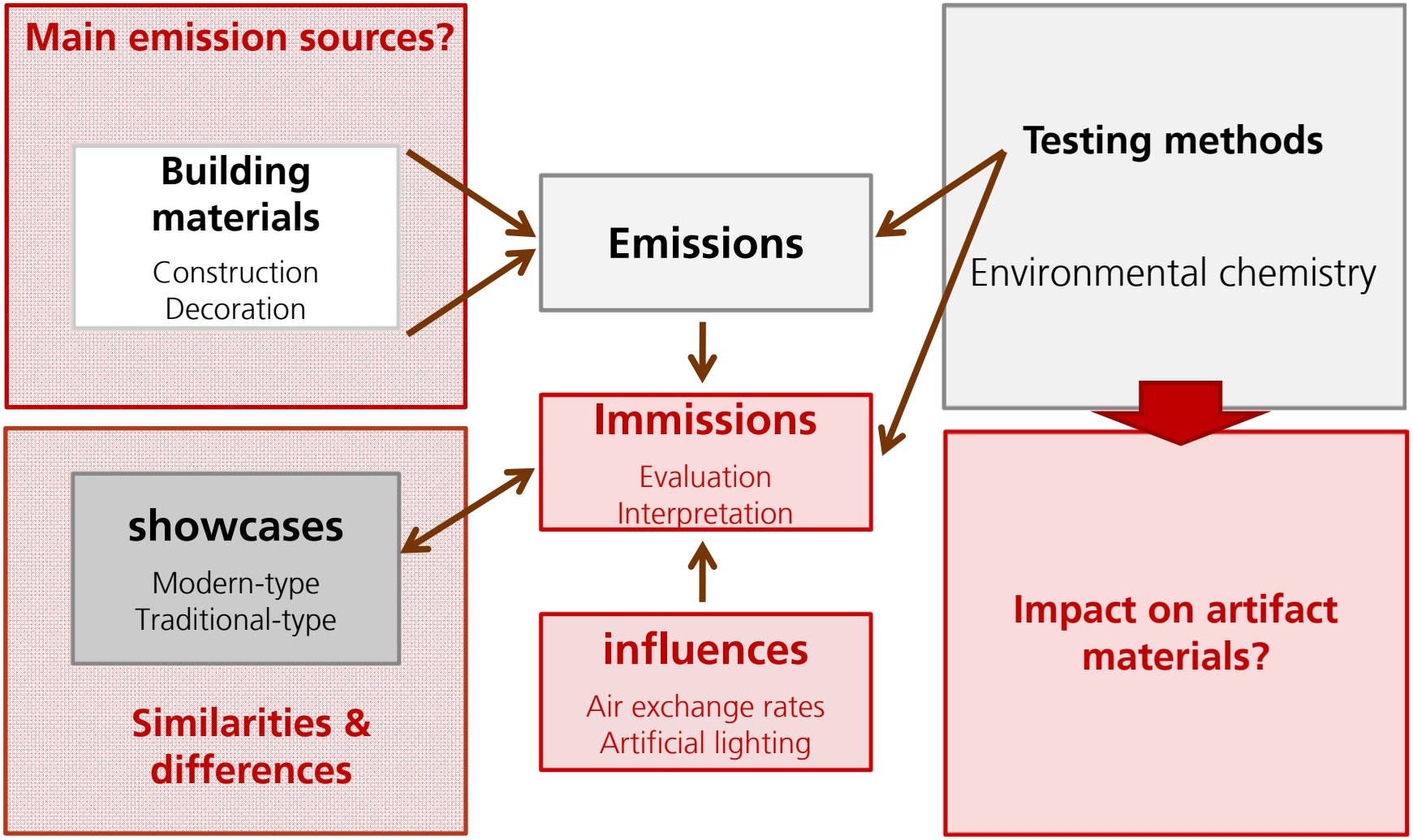
Showcases – a problem?

Kind of nested prevention strategy: „box in a box-model“ [Camuffo et al., 2000]



The museum showcase as a „reaction vessel“ [Weschler and Shields, 1997]

Course of the project



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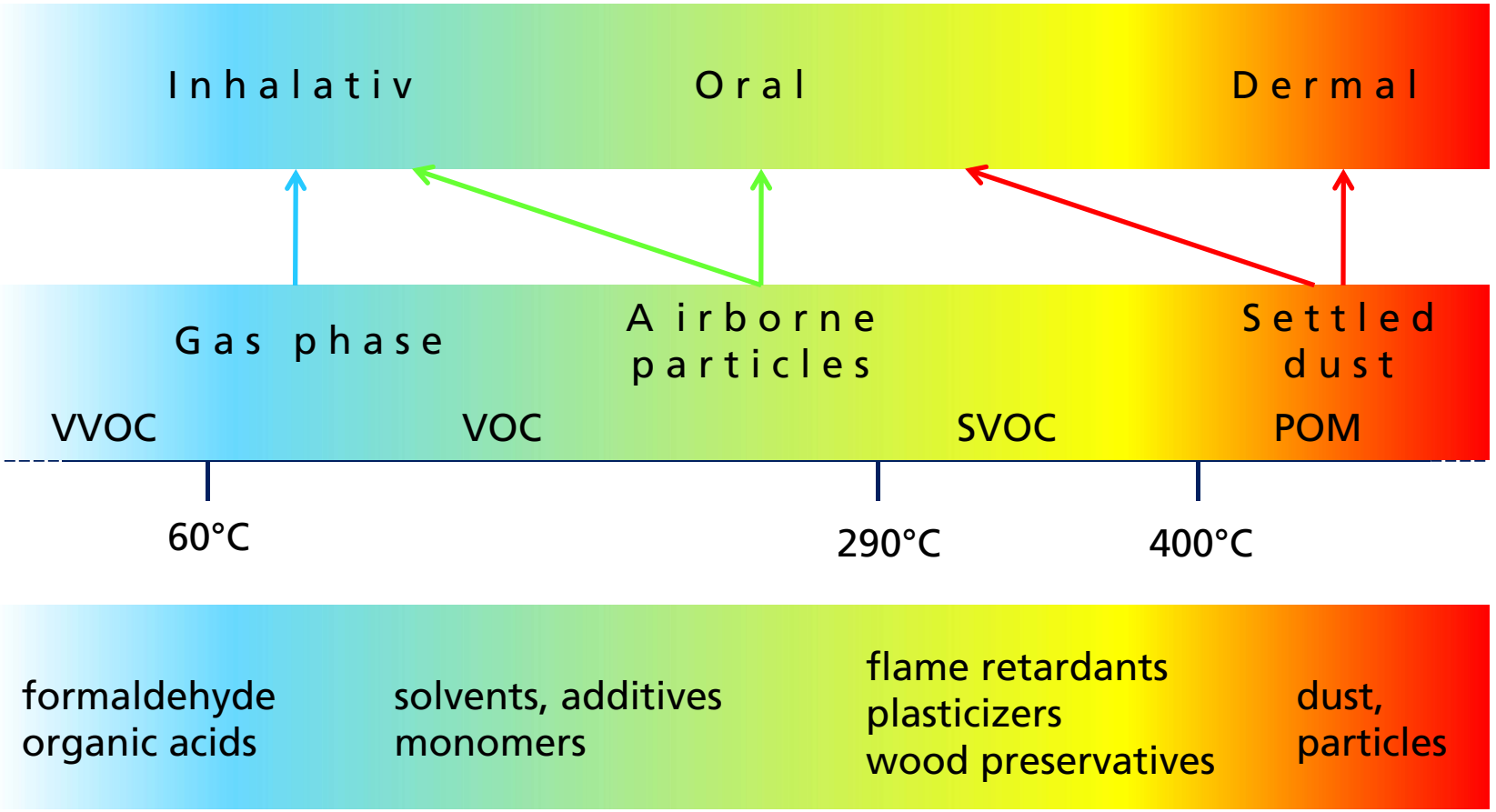
Classification of pollutants
– emissions of indoor materials



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Active indoor air sampling techniques

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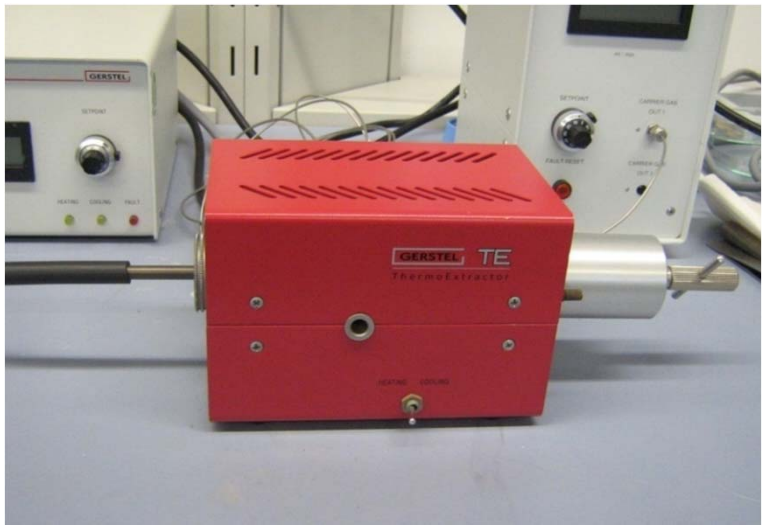
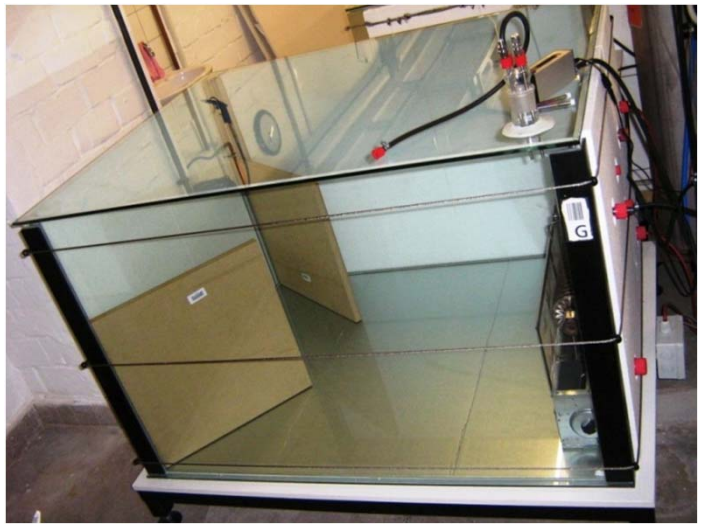
Material emission analysis





Temperature [T]:	23°C-350°C	23 ± 2°C
Relative humidity:		50 ± 5%
Air exchange rate [n]:	233 h^{-1}	0,18 h^{-1}
Loading factor [L]:		0,5 bzw. 0,03 m^2/m^3
Sample sizes:	10 x 70 mm	0,5 m^2 (plane samples)
	10 x 45 mm	0,03 m^3 (voluminous samples)

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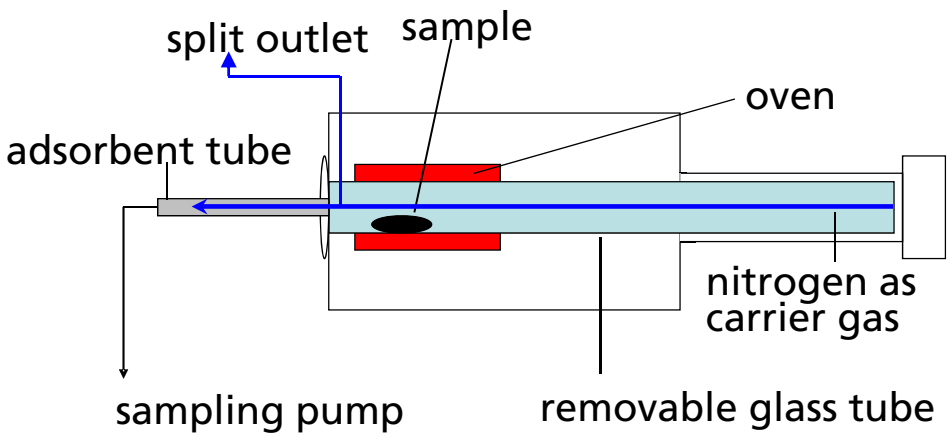
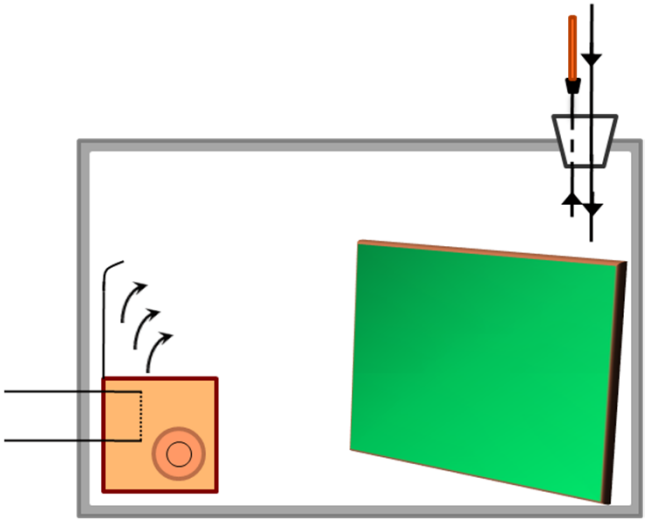
Material emission analysis





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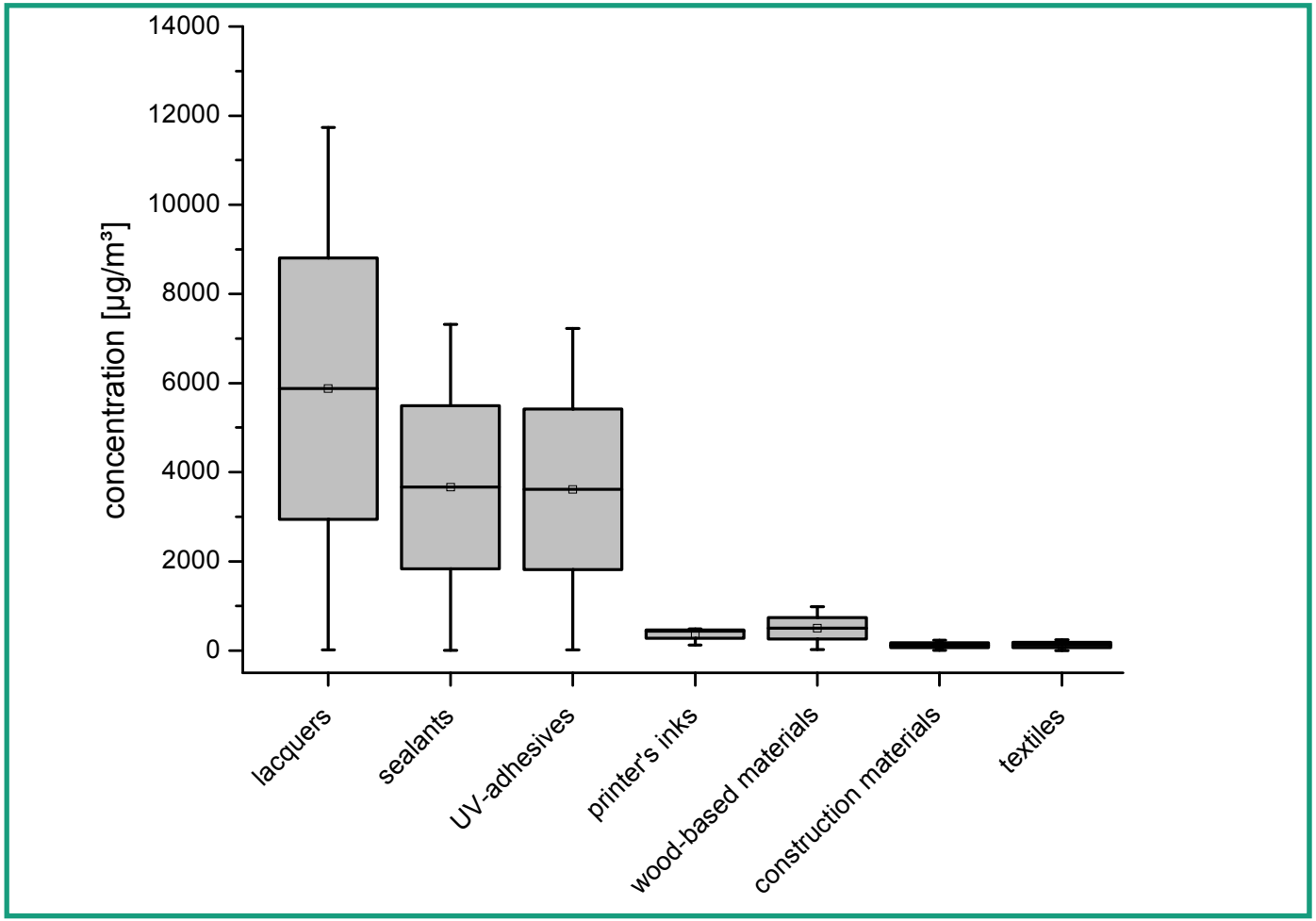

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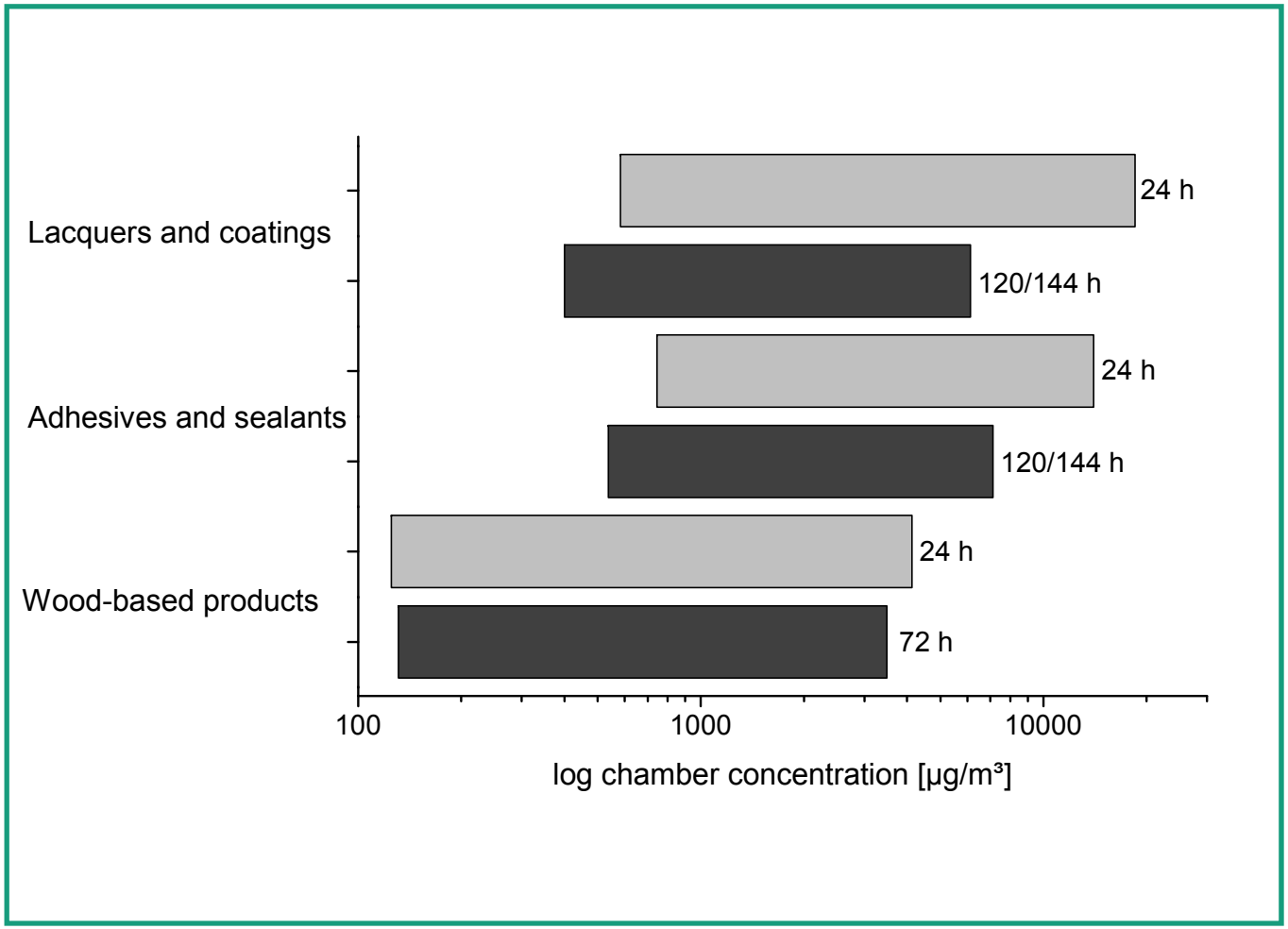

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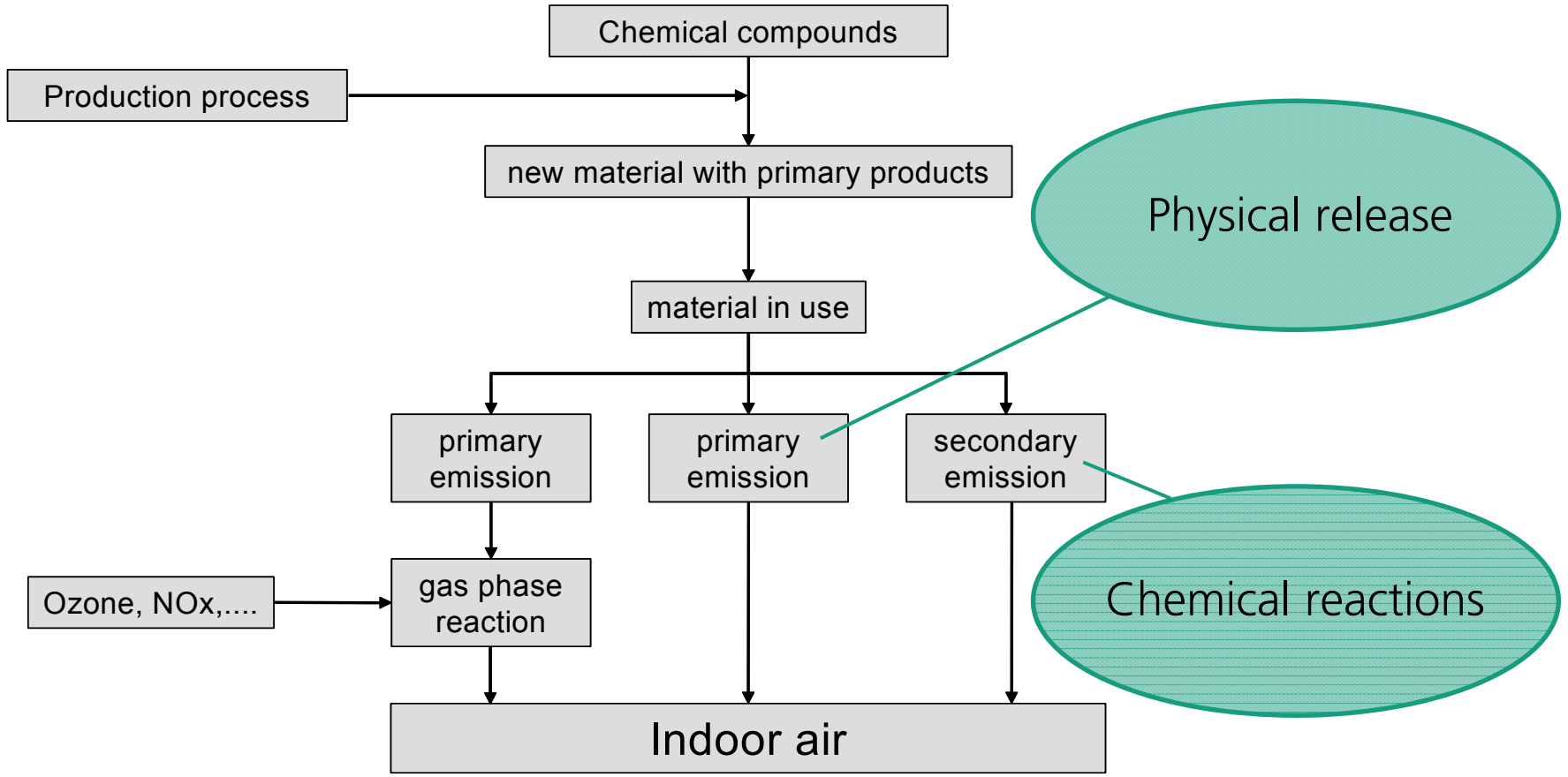
Primary emissions – secondary emissions



[Uhde and Salthammer, 2007]

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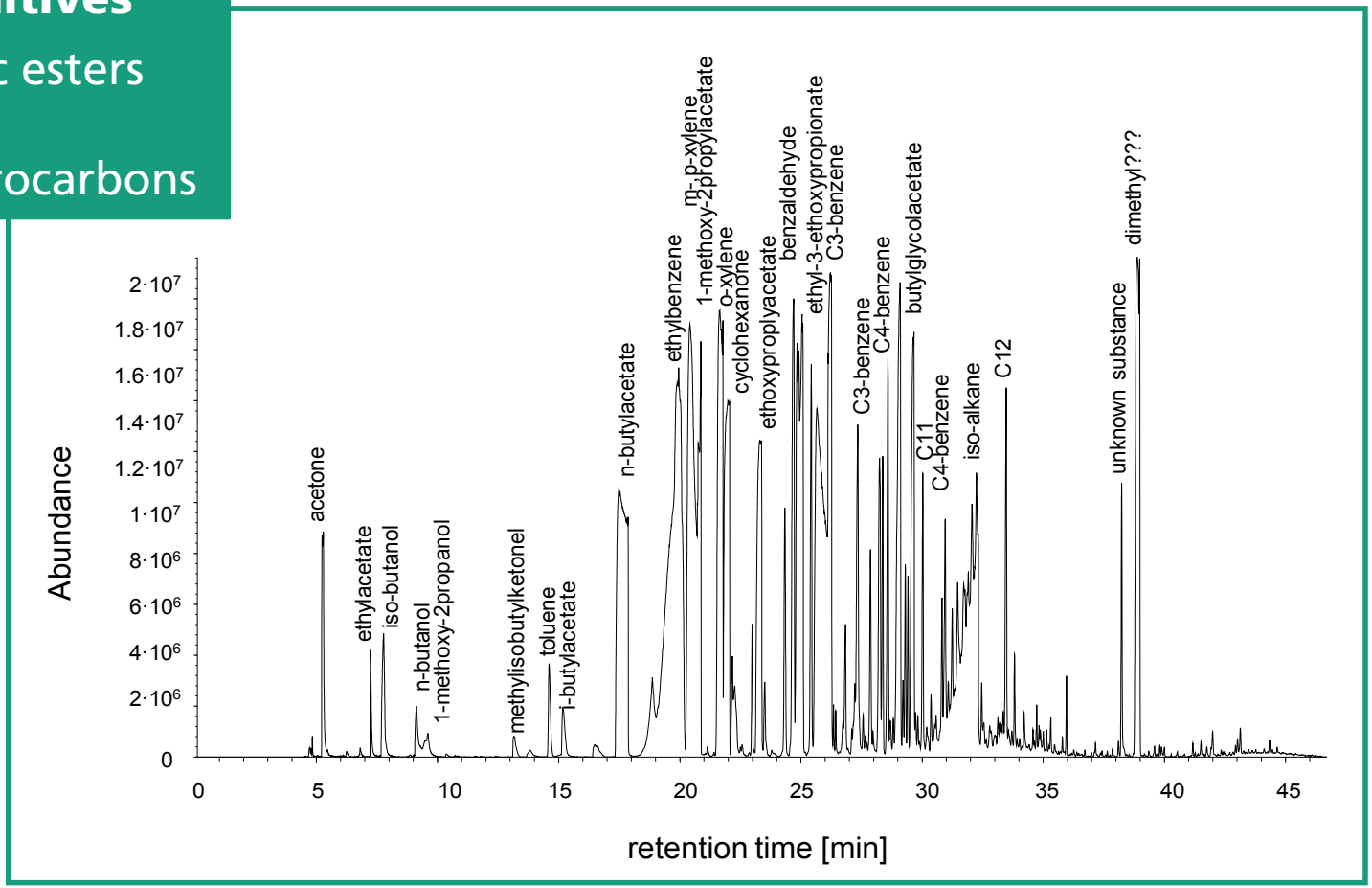
Solvent-based lacquers *versus* powder coatings

Solvents/additives

(Di-)Carboxylic esters
Glycols
Aromatic hydrocarbons



[Schieweck and Salthammer, 2009]

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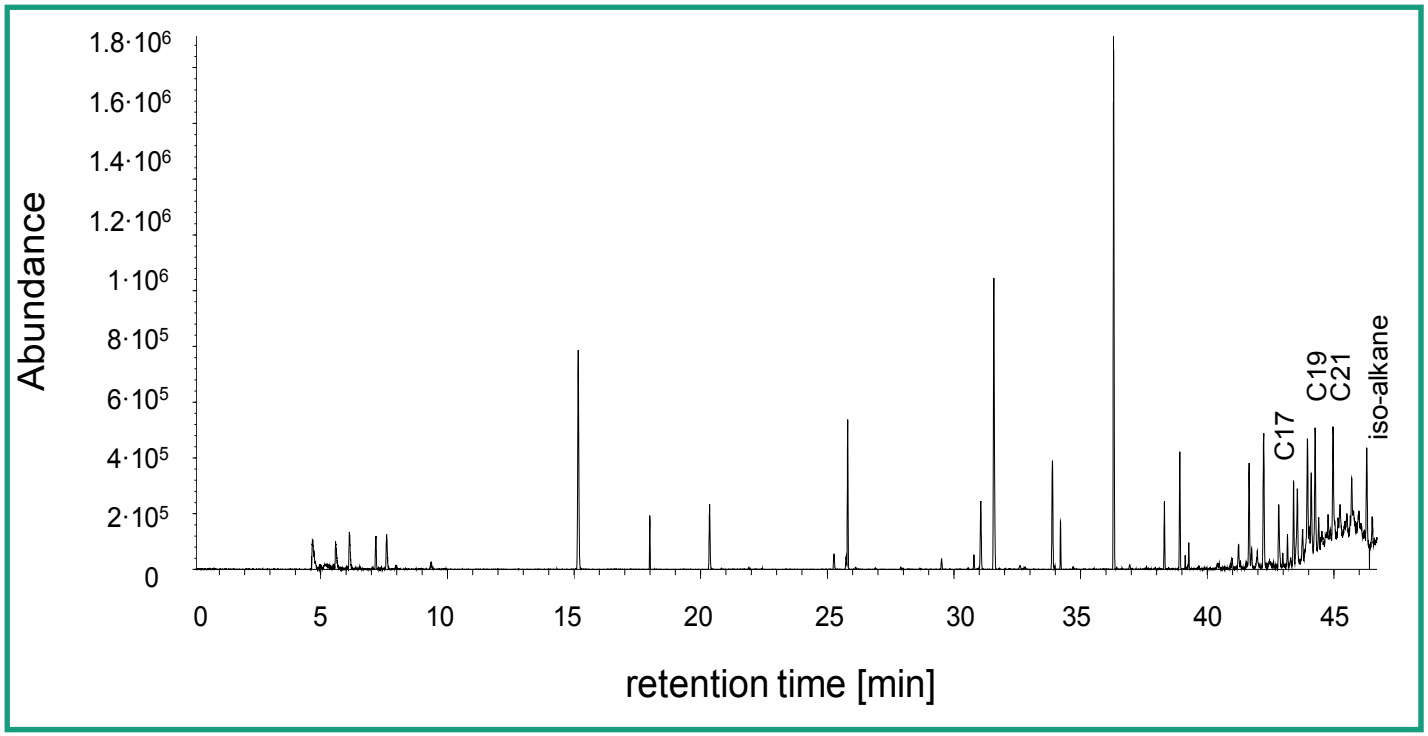
Solvent-based lacquers *versus* powder coatings

Long-chained alkanes



[Schieweck and Salthammer, 2009]

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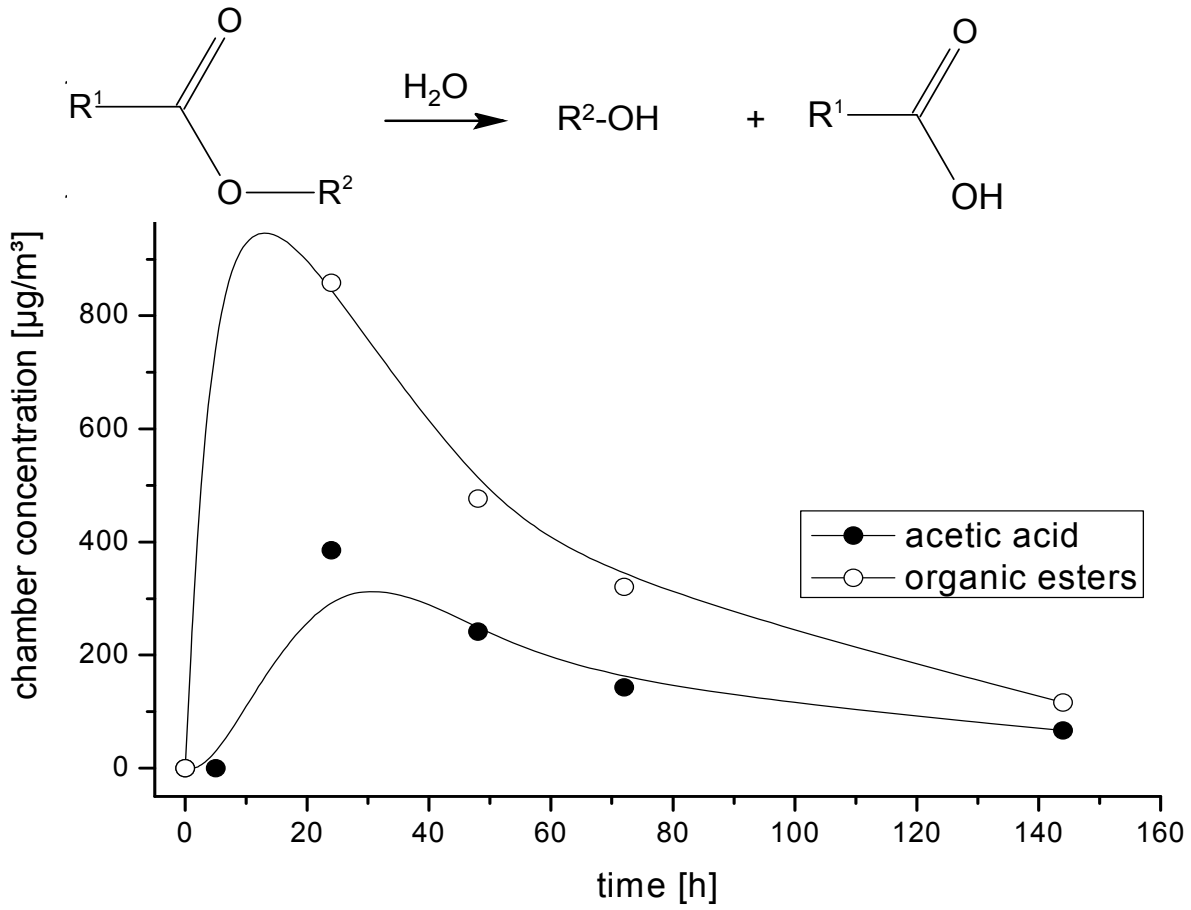
Secondary emission of solvent-based lacquers

Ester hydrolysis



[Schieweck and Salthammer, 2009]

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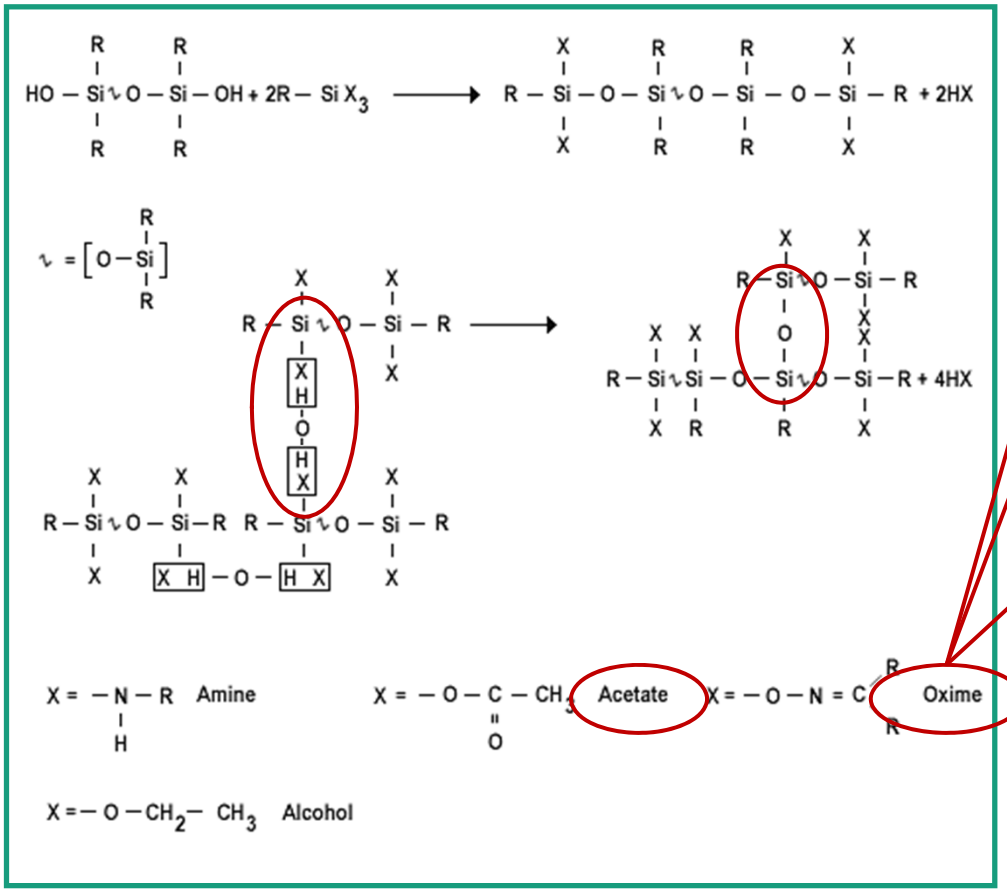
Silicone rubber sealants (RTV-1)



Decomposition products of cross linking agents

2-butanone oxime (MEKO) Canc.Cat. 3

4-methyl-2-pentanone oxime

2-propanone oxime

cyclic siloxanes

solvents

[CEC-Centre Européen des Silicones]

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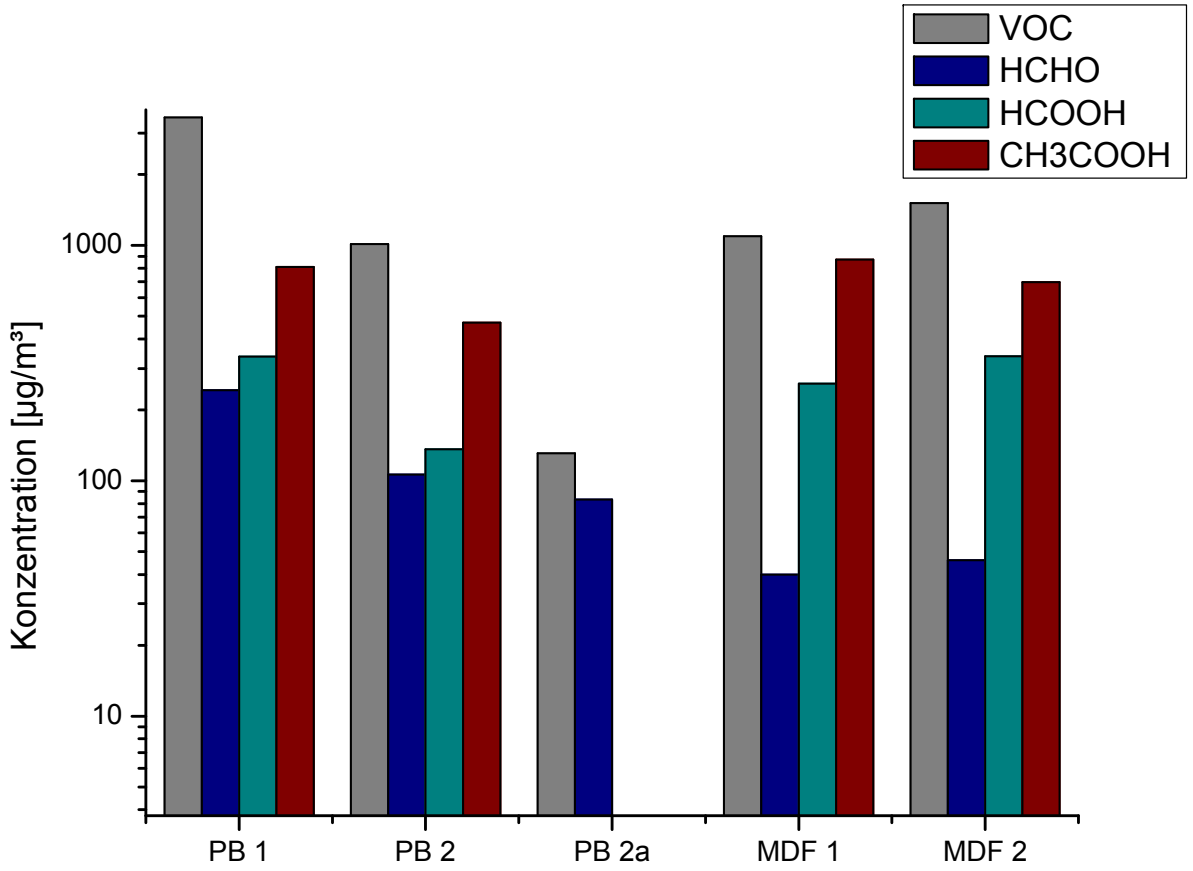
Wood-based products

Aldehydes
Terpenes
Organic acids
Formaldehyde



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Wood-based products

Fibre boards

E1 equilibrium concentration in chamber air HCHO: < 0.1 ppm

RAL-UZ 76 („Blue angel“) equilibrium concentration in chamber air HCHO: < 0.05 ppm

MDF

ZF „zero added formaldehyde“

Z0 no formaldehyde-based binder

- Material safety data sheets etc. commonly do not provide any information regarding:
  - emissions / emission potential (in time; composition)
  - odorous compounds
  - secondary emissions
- Labelling systems: what do they mean? How is the test procedure?
- Industrial product formulations might have a great impact on emissions
- „emission-free“ ↔ low-emissive

Investigated showcase types

- passive (no active air circulation)
- modern *versus* traditional
- sealed *versus* open

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Traditional-type showcases

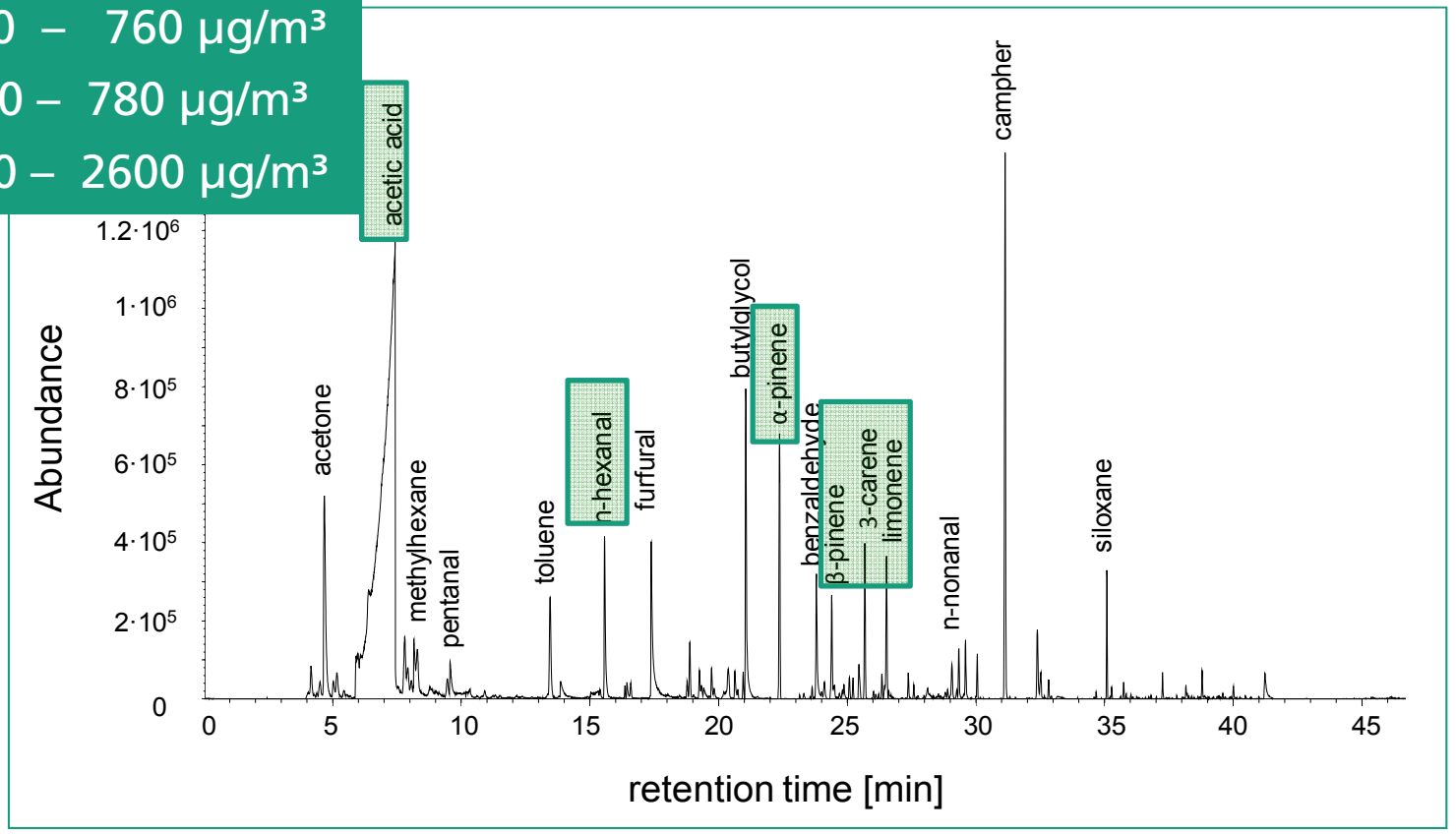
V: 0.5 m³ – 12 m³

Σ(VOC): 100 – 2800 µg/m³

HCHO: 70 – 760 µg/m³

HCOOH: 100 – 780 µg/m³

CH_3COOH: 450 – 2600 µg/m³



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Modern-type showcases

V: 0.68 m³ – 1.45 m³

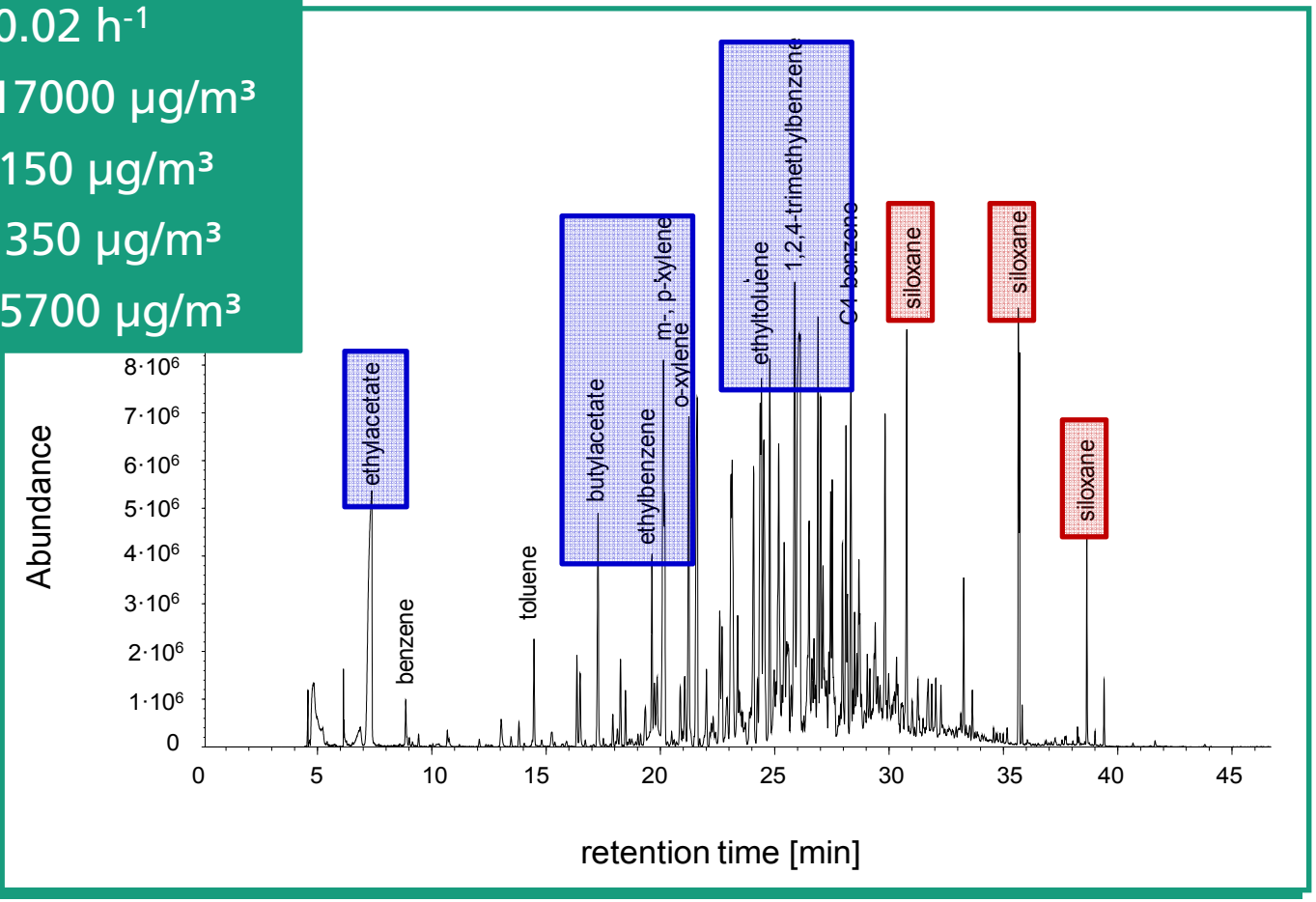
n: 0.01 h^{-1} – 0.02 h^{-1}

Σ(VOC): 100 – 17000 µg/m³

HCHO: < NG – 150 µg/m³

HCOOH: < NG – 350 µg/m³

CH_3COOH: <NG – 5700 µg/m³



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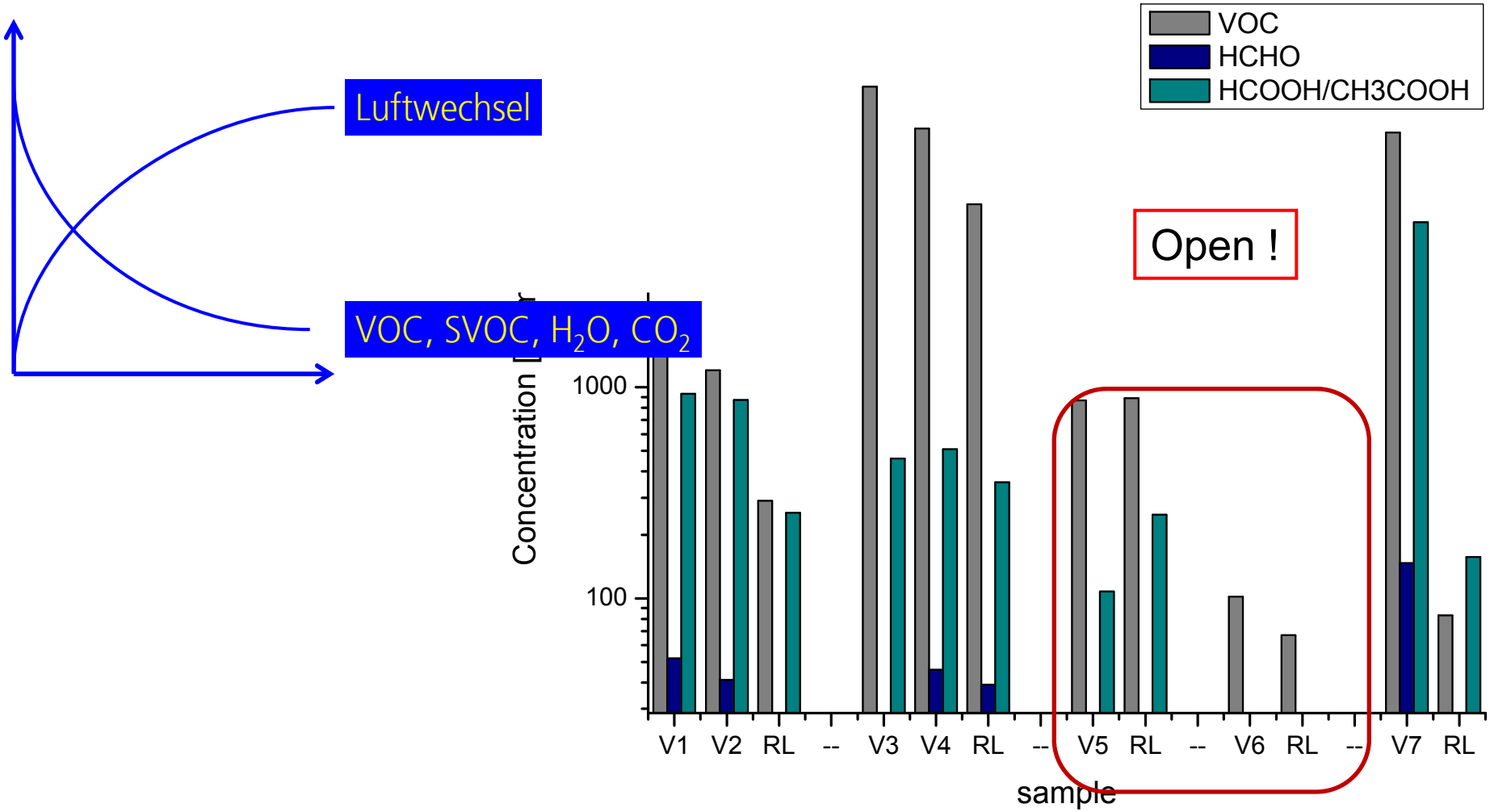
Influence of air exchange rates on imissions



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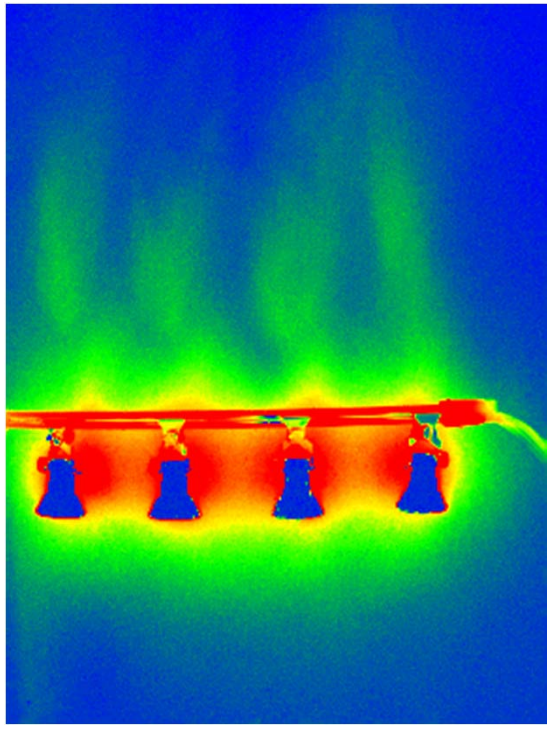
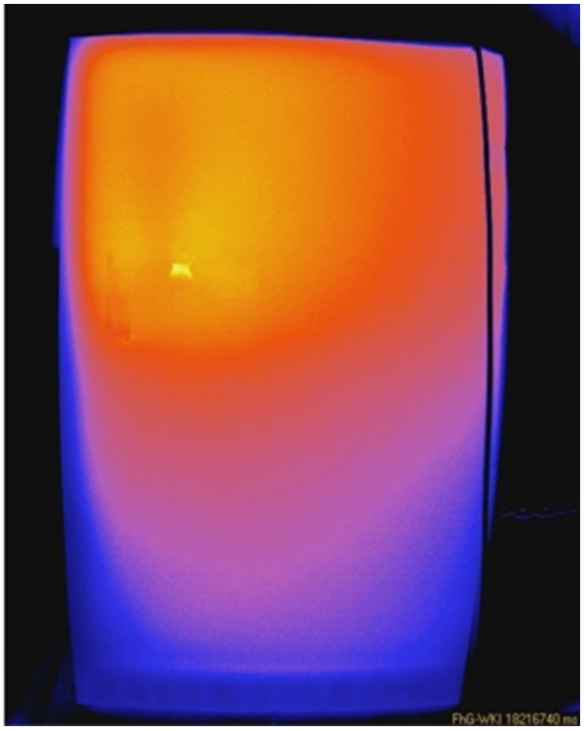
Air flows and temperature distribution within showcases





Local air flows around the lamps

No air circulation over the whole showcase

Negativ temperature gradient from the top to the bottom

Temperature difference: max. 4°C

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Conclusions

The choice of building materials determines indoor air quality and pollution levels

Main emission sources: solvent-based lacquers, silicone sealants, wood-based products

Highly sealed showcases promote the accumulation of emissions inside

Open constructed showcases show minor pollutant concentrations provided that background values are also low

Now reduction of emissions due to shift in material selection

Conclusions

Potential hazardeous impact on cultural assets?

Hard to asset as no alterations yet can be traced back to impact of VOCs

ALARA-concept: emissions should be kept „**a**s **l**ow **a**s **r**easonably **a**chievable“

NOEAL-values [Tétreault, 2003] should not be exceeded

This study provides a first basis regarding

-Evaluation concepts

-Labelling systems

Airborne pollutants in museum showcases – material emissions, influences, impact on artworks

The PhD-thesis is available online as full article:

www.hfbk-dresden.de

Studium

Restaurierung

Wissenschaftliche Arbeiten und Publikationen

Dissertationen

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We acknowledge

The Stiftung Industrieforschung
Cologne/Germany
for financial support (# S 727)

The German National Academic
Foundation for a dissertation fellowship

Federal Ministry of Economics and Technology

Reduction of indoor air pollutions from museum showcases by the application of absorbent materials and “intelligent” material systems

05/2010 – 04/2012

THANKS FOR YOUR ATTENTION

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