Short Report

Examination of the erosions of building elements made of wood, plastic, metal and glass for evaluating the impact on the soil and groundwater

of the Research Centres

ift gemeinnützige Forschungs- und Entwicklungsgesellschaft mbH

Fraunhofer-Institut für Bauphysik IBP, Holzkirchen branch

The research project has been sponsored by finances provided by Zukunft Bau (the research initiative of future-oriented construction) of the Federal Institute for Research on Building, Urban Affairs and Spatial Development.
(File reference: II 3-F-20-12-1-040/SWD-10.08.18.7-13.10)
The authors are responsible for the contents of this report.

Short report

Topic	Examination of the erosions of building elements made of wood, plastic, metal and glass for evaluating the impact on the soil and groundwater
Short title	Erosion of Building Elements
Sponsored by	Research initiative Zukunft Bau (on future-oriented construction) of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (File reference: II 3-F-20-12-1-040/SWD-10.08.18.7-13.10)
Research Centres	
ift ROSENHEIM	**Research Centre:** ift gemeinnützige Forschungs- und Entwicklungsgesellschaft mbH Theodor-Gietl-Str. 7-9 83026 Rosenheim **Project Management:** Benno Bliemetsrieder, MBA, Dipl.-Ing. (FH) **Project Handling:** Benno Bliemetsrieder, MBA, Dipl.-Ing. (FH) Miriam Kaube, B. Eng. **Director of the Institute:** Prof. Ulrich Sieberath
Fraunhofer IBP	**Research Centre:** Fraunhofer-Institut für Bauphysik IBP Holzkirchen branch Fraunhoferstr. 10 83626 Valley **Project Management:** Dr.-Ing. Christian Scherer **Project Handling:** Dr.-Ing. Christian Scherer Dr.-Ing. Regina Schwerd Christoph Schwitalla, Dipl.-Ing. (FH) Friederike Externbrink

Table of Contents

1 Problem Description and Objectives

The European Construction Products Directive (EU No 305/2011) [1], which has come into full legal effect on 1 July 2013, just like the European Construction Products Regulation (89/106/EEC) [2], addresses the aspects of hygiene, health and environmental conservation as the basic requirement for buildings --no. 3 (BWR 3).

In addition to the requirements for building products regarding radioactive radiation and emissions of volatile organic compounds (VOC) into the indoor room air, even the potential erosion of hazardous substances into the soil and groundwater are being addressed. The objective is to avert risks for the natural resources by constructions and to conserve valuable ecological assets such as groundwater and the soil against deteriorative impacts. For building elements in the building shell or in the surroundings of the building, which are exposed to weathering (see Figure 1), the focus is primarily on the potential ingress of hazardous substances from these building elements into the soil, groundwater and surface water.

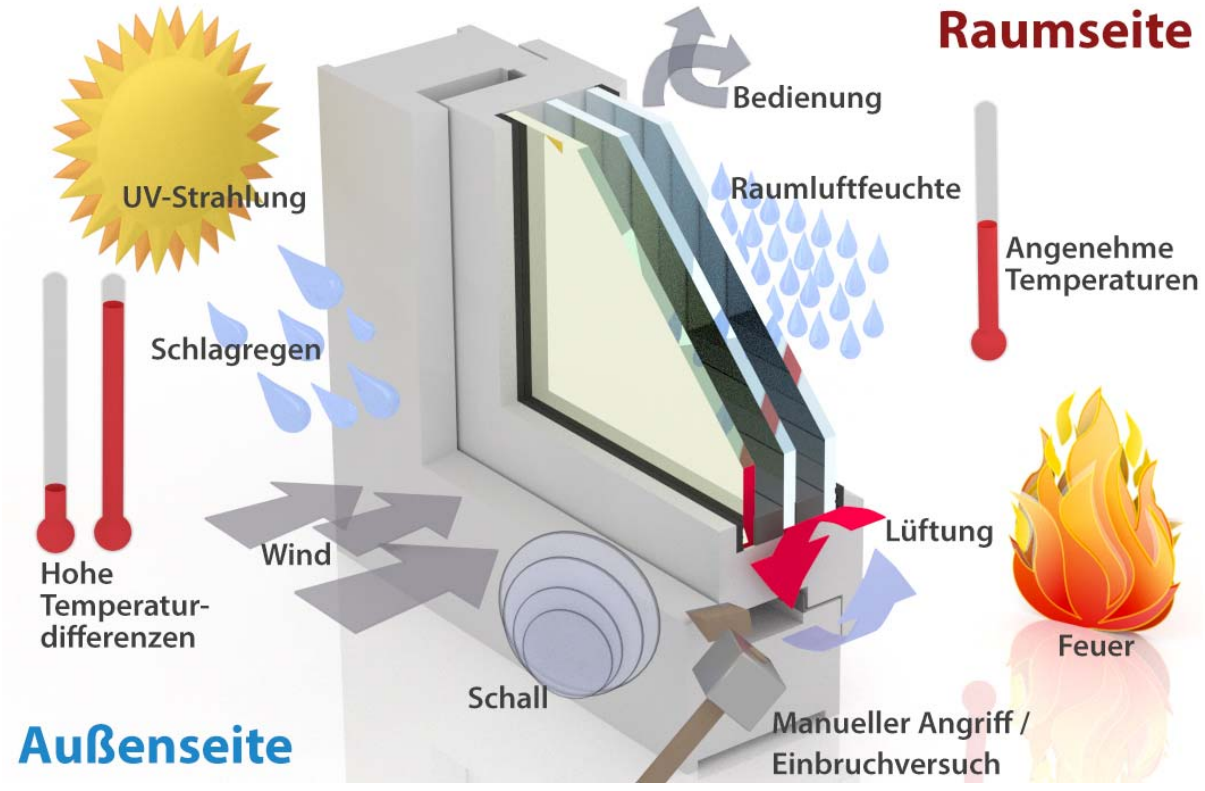


Figure 1 Different impacting factors on building elements in building envelope

The overall aim of the research project was to make a detailed investigation of the erosions of building elements of the building shell made of wood, plastic, metal and glass. In this way, it was meant to create a comprehensive database, which can be used in future for developing a method to estimate the impact of the product groups mentioned on the soil and groundwater.

2 Procedure

A representative selection of window elements was used for the examination under natural conditions of weathering outdoors. Complete windows elements made of wood, plastic and aluminium were weathered at two different locations (see Figure 3 Details of window installed in the retaining profile and collecting sill and Figure 3 Details of window installed in the retaining profile and collecting sill) and the rainwater drained off was analysed regarding various chemical test parameters.

Figure 2 Retaining profiles with installed windows and impact surface

Figure 3 Details of window installed in the retaining profile and collecting sill

In addition to weathering test specimens outdoors under real conditions, the focus was also on a comparison of two different laboratory eluviations [3] [4]. For this purpose, individual components of the selected window elements made of wood, plastic, metal and glass (see Figure 4) were used. The examination process was also supplemented by other individual components representative of the market.

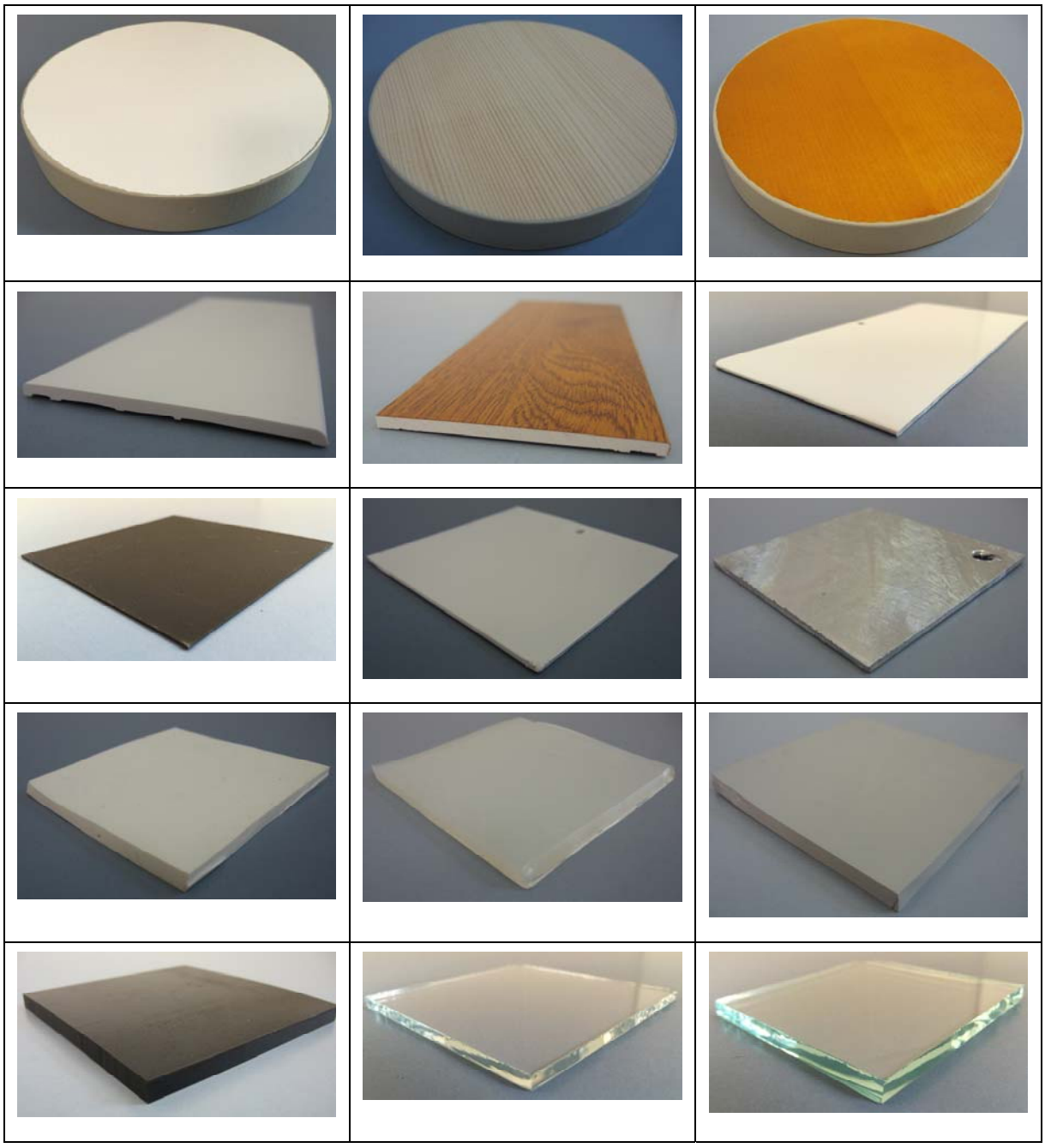
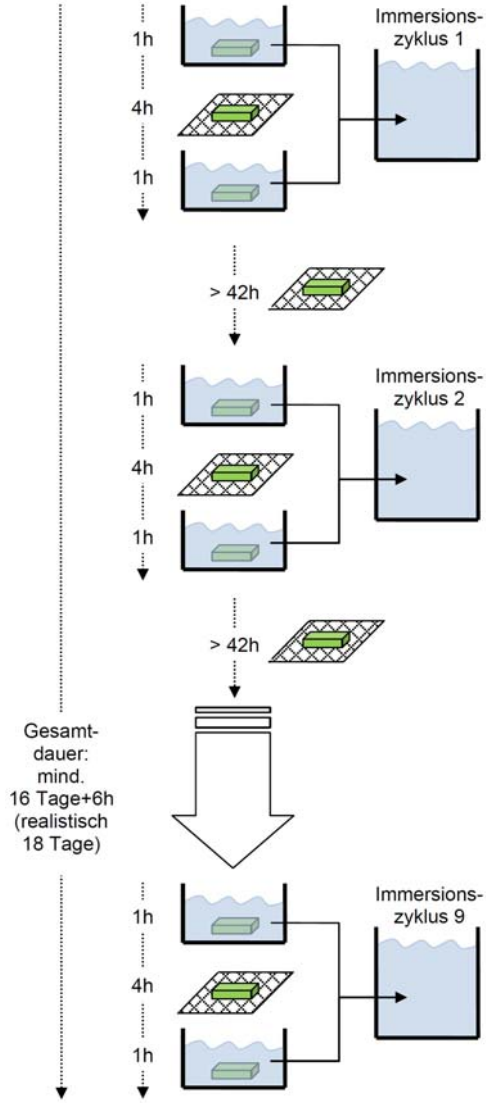
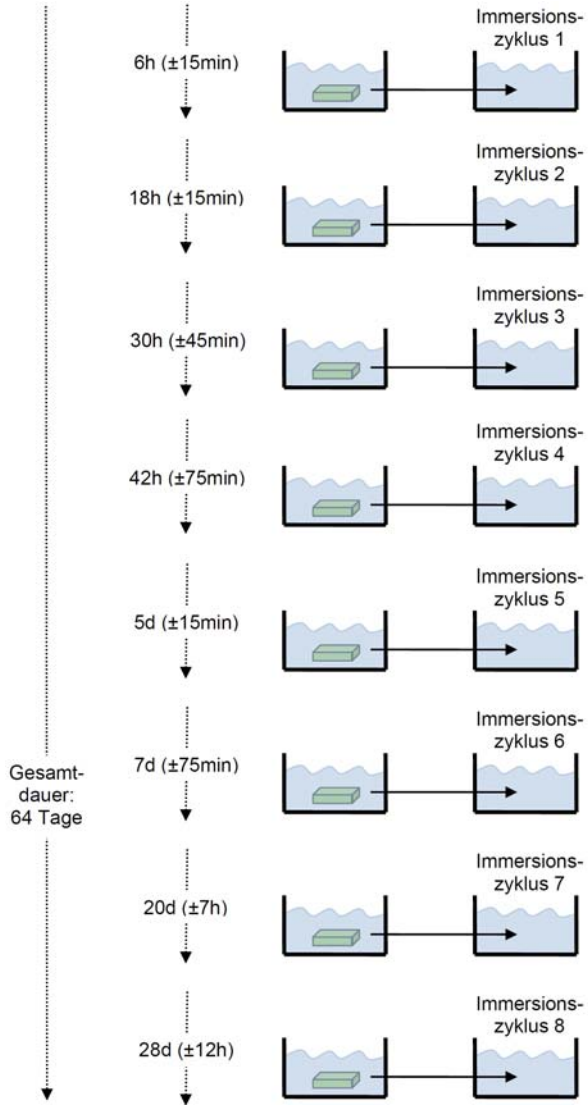


Figure 4 Individual components for laboratory eluviations examinations

All individual components were subjected to two different lab eluviations examinations (see Table 1) and the eluate recovered in this manner were analysed. Regardless of their respective condition of installation in reality with the characteristic proportion of quantity and area of the complete windows, all individual components were exposed to identical test conditions.

Table 1 Procedure of the laboratory eluviations examinations

DIN EN 16105	DIN CEN/TS 16637-2
Details: – Conditioning 23 °C, 50 % relative humidity – Ratio of the test specimen surface area to the volume of water: 25 l/m² – Always double determination + dummy value – Drying phases within as well as between the nine immersion cycles – The eluates obtained from one day of immersion are combined	Details: – Conditioning 23 °C, 50 % relative humidity – Ratio of the test specimen surface area to the volume of water: 25 l/m² – Always double determination + dummy value – Test specimen continuously in contact with water (no drying phases) – Eight changes of eluates, total duration of the test: 64 days
	

The findings obtained are meant to provide information about

- the type of substances released with the different methods of eluate recovery,
- their quantity and
- the composition of the respective collective materials contained.

3 Findings regarding the examination methodology

Based on their complexity and size in particular, complete building elements such as windows and facades are not suitable for the laboratory methods in accordance with DIN EN 16105 [3] and DIN CEN/TS 16637-2 [4]

Both laboratory procedures (DIN EN 16105, DIN CEN/TS 16637-2) [3] [4]) can basically be applied to individual components of windows and facades made of wood, plastic, metal and glass. Depending on the parameters, the procedures with identical individual components may lead to different results.

When using freshly produced galvanised steel specimens, the procedure in accordance with DIN CEN/TS 16637-2 [4] leads to the formation of excessive white rust. This substantial change in the properties of the test specimen confirms that the procedure in accordance with DIN CENT/TS 16637-2 for hot-dip galvanised test specimens appears to be unsuitable and that these test specimens have been justifiably excluded from the scope of application. For other the test specimens of the metal sector the method according to DIN CEN/TS 16637-2 seems definitely appropriate.

Based on the fact that the examination procedure being closer to reality in terms of contact with water and the drying phases, the method according to DIN EN 16105 [3] seems to be more suitable for examinations of the erosion behaviour on individual components of building elements made of wood, plastic, metal and glass, such as e.g. windows and facades.

In weathering outdoors, complete building elements such as windows and facades can be examined regarding the erosions. The installation situation exposed to the weather in the test set-up of the research project setup represents a worst case scenario compared with the installation of windows elements in a flat facade. Outdoor weathering is not suitable as a routine examination for this group of products for the following reasons:

- The site conditions have a certain impact on the measurement results.
- The climatic conditions cannot be reproduced.
- The cost and effort for such examinations under conditions of outdoor weathering is very high.

Direct comparisons or correlations between outdoor weathering and the two laboratory methods are not possible for the following reasons:

- Under outdoor conditions, the test specimens consist of complete window elements in which, based on the model and variant, several components with varying proportion of mass and surface area are combined with one another.
- The laboratory eluviations examinations are performed on individual components. The ratio of volume/surface area is identical for all materials.
- The procedures for the two laboratory methods differ from one another in the general flow and all boundary conditions considerably from the conditions under outdoor weathering.

Outdoor weathering reflects the order of substances released under realistic conditions by complex building elements such as e.g. windows and facades at the respective weathering location. Laboratory tests with individual components provide an insight on potential sources of eroded substances.

Individual components made out of wood, plastic, metal and glass have very different proportions of mass and surface area in the complete building elements such as e.g. windows and facades. The respective ratio should basically be taken into consideration in case of a potential evaluation in the course of laboratory examinations. This could be carried out with the help of a ratio of product surface area to the eluate volume fixed product specifically or by means of calculation after conducting the experiment before the evaluation.

4 Findings with respect to the evaluation of the test specimens examined

For the building elements, or the individual components installed in them, considered in the project – depending on the respective product considered – measurable values of erosion could be determined both in outdoor weathering and in the two laboratory methods. With the exception of the biocide propiconazole and the phenol index, the eluate concentration levels obtained were primarily within the range of the background values or they were below the limits of determination by the analytical measurement methods. An evaluation of the eroded substances regarding any potential hazard potential cannot be done due to the fact that the evaluation models have not (yet) been specified at present.

The sealants and coating systems examined for wooden surfaces may be a source for the erosion of biocides (e.g. propiconazole). With appropriate selection of wood and/or optimised constructive wood preservation, you can dispense with the use of biocides in coating systems for wooden surfaces. The effect of the biocides added to the sealants examined is primarily aimed at fungal infestation caused by formation of dew indoors. Hence, you can also dispense with the use of biocides in relevant formulations for outdoor use.

Evaluation of the erosions of building elements with the help of laboratory examinations requires a mathematical model, which sets up a correlation between the measured values at the site of occurrence (laboratory eluviations examinations) and existing evaluation criteria (e.g. minor threshold values) in the soil and groundwater. Such a model does not exist at present for the product group considered. You cannot derive a recommendation for product testing and monitoring regarding the erosion of building elements such as windows and facades made out of wood, plastic, metal and glass.

A comparison of the results and findings of the research project executed with other product groups is not possible based on different priorities of the examination and framework conditions.

5 Acknowledgement

The research project based on this report was sponsored by funds of the research initiative Zukunft Bau of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt, und Raumforschung) (File reference: II 3-F-20-12-1-040/SWD-10.08.18.7-13.10). The authors are responsible for the contents of this report.

The research project has been supported by a working group accompanying the project in an advisory capacity. We would particularly like to thank the members of the advisory body:

Ms. Johanna Bartling	Deutsches Institut für Bautechnik (DIBt) Environmental conservation
Ms. Outi Ilvonen, Dr. Johanna Wurbs	Federal Environment Agency Specialist field III 1.4 Material-related product issues
Dr. Holger Nebel	Chair of Building Materials Science at the Institute for Building Materials Research (ibac, Institut für Bauforschung) of the University Aachen

We would in particular like to thank the following industry partners who have supported the entire project financially and ideally and, thus, have contributed to its success:

BF Bundesverband Flachglas	Bundesverband Flachglas e.V. Mülheimer Str. 1 53840 Troisdorf
DOW CORNING	Dow Corning GmbH Rheingaustrasse 34 65201 Wiesbaden
remmers schützt Werte am Bau	Remmers Baustofftechnik GmbH Bernhard-Remmers-Str. 13 49624 Löningen

SCHÜCO	Schüco International KG Karolinenstr. 1-15 33609 Bielefeld
SEMPERIT	Semperit Gummiwerk Deggendof GmbH Land-Au 30 94469 Deggendorf
	Verband der deutschen Lack- und Druckfarbenindustrie e.V. (VdL) Mainzer Landstraße 55 60329 Frankfurt am Main
VFF Verband Fenster + Fassade	Verband Fenster + Fassade Walter-Kolb-Str. 1-7 60594 Frankfurt am Main

6 Bibliography

[1] EU No. 305/2011
ORDINANCE (EU) No. 305/2011 OF THE EUROPEAN PARLIAMENT AND COUNCIL dated 9 March 2011 for specifying harmonised conditions for marketing construction products and for revocation of the Directive 89/106/EEC of the Council; Official Gazette of the European Union, L88/5 – 43 dated 4 April 2011.

[2 Construction Products Directive
Directive of the Council dated 21 December 1988 for harmonising the legal and administrative regulations of the member states for construction products.(89/106/EEC) CEN, Brussels, 1988.

[3] DIN EN 16105
Paints and varnishes - Laboratory method for determination of release of substances from coatings in intermittent contact with water DIN EN 16105:2011-12
Beuth Verlag GmbH, Berlin, 2011.

[4] DIN CEN/TS 16637-2
Construction products – Evaluation of the release of hazardous substances - Part 2: Horizontal dynamic surface leaching test; DIN CEN/TS 16637-2:2014-11; DIN SPEC 18046-2:2014-11, Beuth Verlag GmbH, Berlin, 2014.