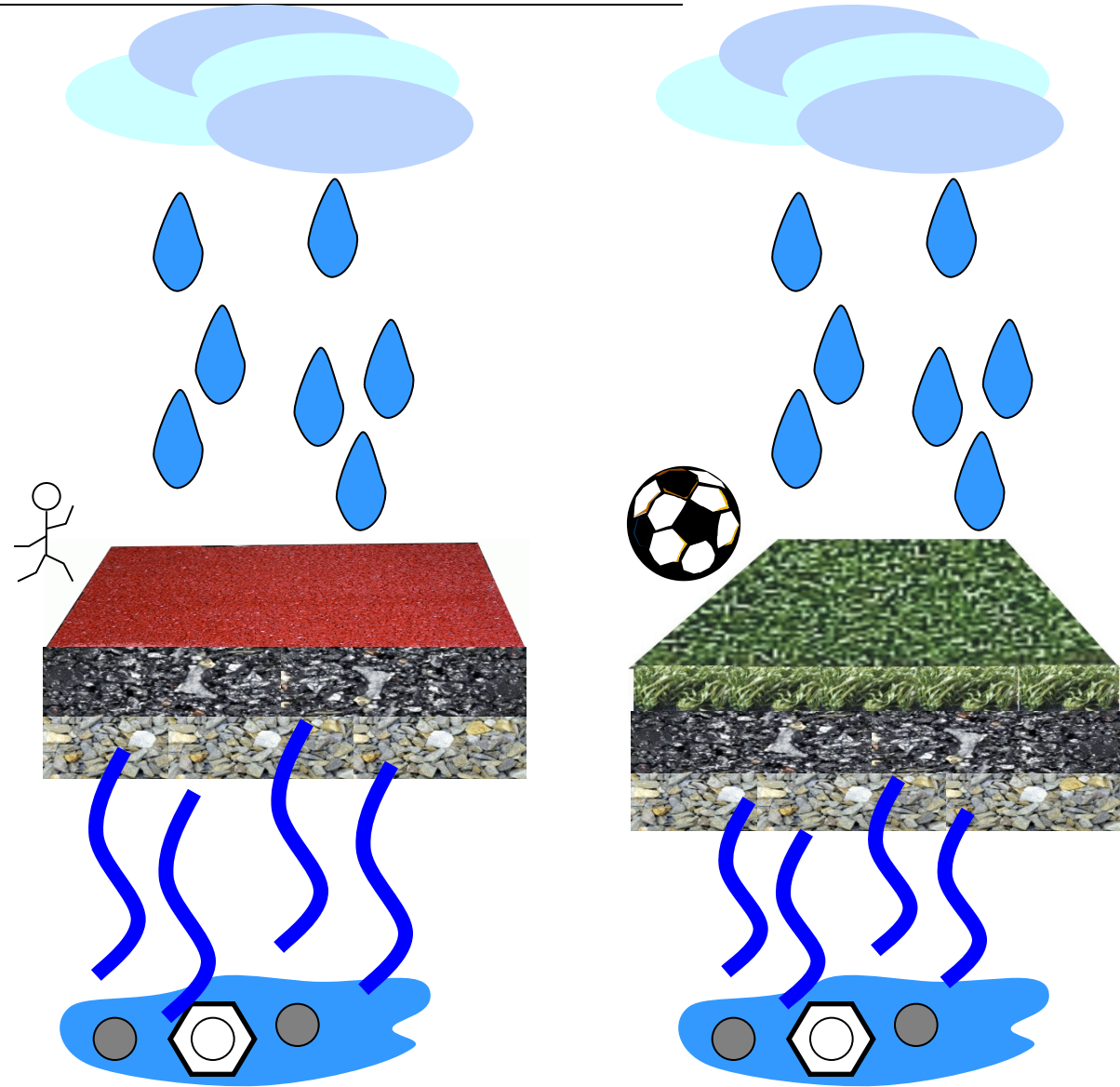


Development of a leaching test to estimate emissions from synthetic sports grounds into soil and ground water under weathering exposure

Volker Wachtendorf, Ute Kalbe, Oliver Krüger, Wolfgang Berger, Anja Geburtig
BAM Federal Institute for Materials Research and Testing, Berlin, Germany

1. Introduction
2. Experimental
3. Results
4. Conclusions



- 1. Introduction**
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Limits to Service Life

- **usually:**
 - **degradation in essential property:**
 - mechanical stability (cracks, delamination)
 - surface erosion (gloss loss)
 - optical properties (transparency, discoloration)
 - ▶ **“failure” limits use**
- **here:**
 - **emissions of environmental relevance into soil and ground water due to degradation of polymeric matrix**
 - ▶ **regulations stop further use.**

Project

- **Funding:**
 - German Federal Institute for Sports Science (BISp)
- **Participants**
 - BAM, Berlin, Germany: weathering, leaching tests, analysis
 - ECT GmbH, Flörsheim, Germany: eco toxicological effects
- **Term:**
 - 2 years, 2010 - 2011
- **Goal:**
 - reproducible lab test for quantifying release of substances from sports grounds into soil and ground water

1. Introduction
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Materials

1) Running Tracks

Elastomeric track

Bound sub-layer

Unbound sub-layer



Materials

1) Running Tracks

- B1: recycled SBR + thin layer of spray coated new EPDM (+PUR binder)
- B2: recycled SBR + (thicker) granulate layer of new EPDM (+PUR binder)
- B3: new EPDM (+PUR binder).

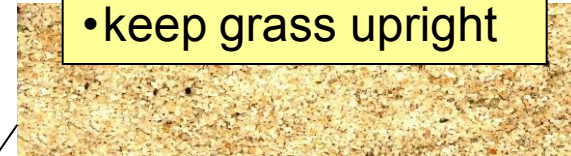
Materials

2) Artificial Turf

- Elastomeric infill (recl. SBR, EPDM, partly PUR coated)
- Quartz sand infill
- Artificial turf (PE, PP)
- Bound sub-layer (SBR+PUR)
- Unbound sub-layer (gravel)



- elasticity
- keep grass upright



Materials

2) Artificial Turf

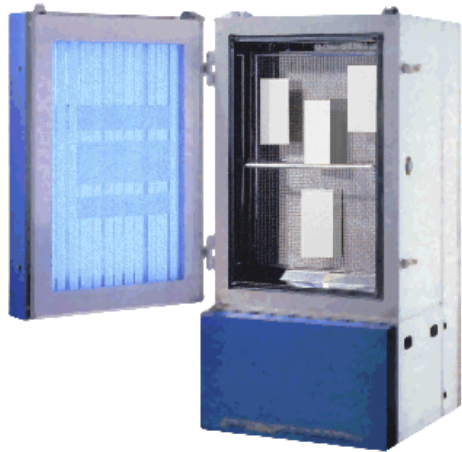
- Single components
 - turf R2, R3, R4 : PE
 - elastomeric infill:
 - SBR 5 (recycled SBR),
 - SBR 8 (recycled SBR + green PUR coating)
- Complete systems
 - R2 + sand + SBR 5.

Materials

Typical Components of SBR Elastomers:

Component	In-organ.	Or-ganic	PAH	Comment
Styrene Butadiene Rubber		X	X	matrix
ZnO	X			activator
Stearic acid				activator
Thiazoles		X	X	accelerators
Stabilizer		X	X	stabilizes against heat, oxygen, ozone

Artificial Weathering

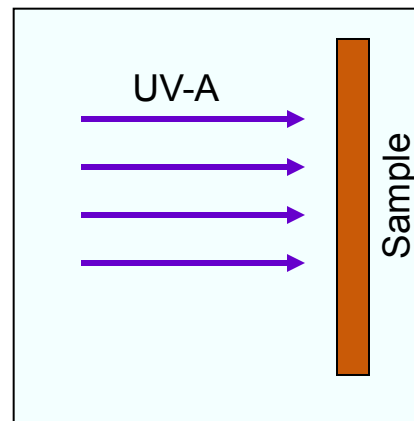


Weiss company,
Global UV-Test 200
(according ISO 4892-3; UVA 340
fluorescence lamps)

- only UV, no VIS, no IR
- ▶ no radiation heating of sample: $T_{\text{chambre}} = T_{\text{sample}}$
- ▶ high humidity on sample surface possible

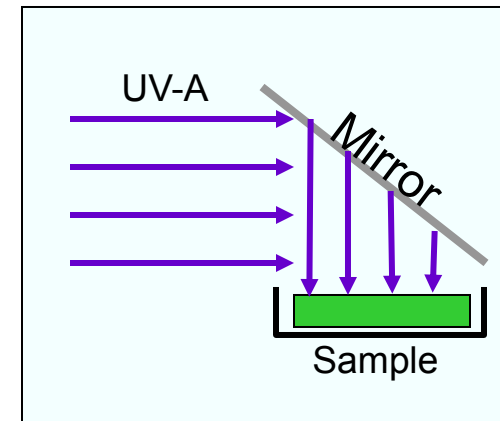
▶ Running Tracks

Vertical orientation

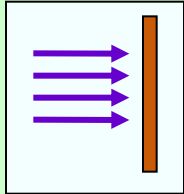


▶ Artificial Turf

Horizontal orientation

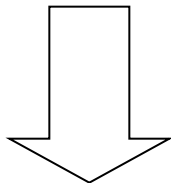


Artificial Weathering: Running Tracks



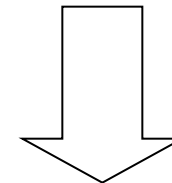
- ▶ Vertical sample orientation
- ▶ UV-A 340 nm fluorescence lamps (45 W/m² UV)
- ▶ Duration: 4200 h (UV equals ≈ 3 years Europe)
- ▶ Temperature, controlled humidity, rain
- ▶ Every ≈1000 h ozone treatment (externally)

Dur.	Temp.	Rel. Humidity
4 h	70 °C	<10 %RH
4 h	25 °C	rain
4 h	70 °C	<10 %RH
4 h	25 °C	rain
4 h	-15 °C	uncontrolled
4 h	25 °C	rain



samples for diff.
stages weathered
in parallel

Leaching tests on solid samples



Analysis of recycled rain water

Artificial Weathering: Running Tracks



0 h	1100 h	2300 h	4200 h weathering
7 d Ozone	14 d Ozone	21 d Ozone	28 d Ozone



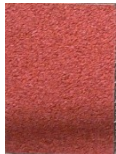
Rain water reservoir:
recycling of water as
long as $< 10 \mu\text{S} / \text{cm}$

Artificial Weathering: Running Tracks

B1
SBR/EPDM



B2
SBR/EPDM



B3
EPDM



Ozone conc.
0,5 ppm

Temperature
30°C

Humidity
90 %RH

Duration 7 d

0 h

1100 h 2300 h 4200 h

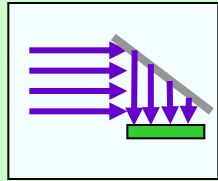
7 d
Ozone

14 d
Ozone

21 d
Ozone

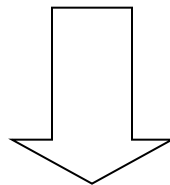
28 d
Ozone

Artificial Weathering: Artificial Turf



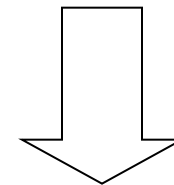
- ▶ Horizontal sample orientation
- ▶ UV-A 340 nm fluorescence lamps, $E_{UV}=20 \text{ W/m}^2$
- ▶ Duration: 2700 h (UV equals ≈ 1 year C. Europe)
- ▶ Temperature, controlled humidity, rain
- ▶ Long contact time granulate / turf with water
- ▶ Every 1000 h ozone treatment

Dur.	Temp.	Relative Humidity
4 h	70 °C	<10 %RH
15 s	25 °C	rain
4 h	35 °C	70 %RH
4 h	70 °C	<10 %RH
15 s	25 °C	rain
4 h	35 °C	70 %RH
4 h	-10 °C	uncontrolled.



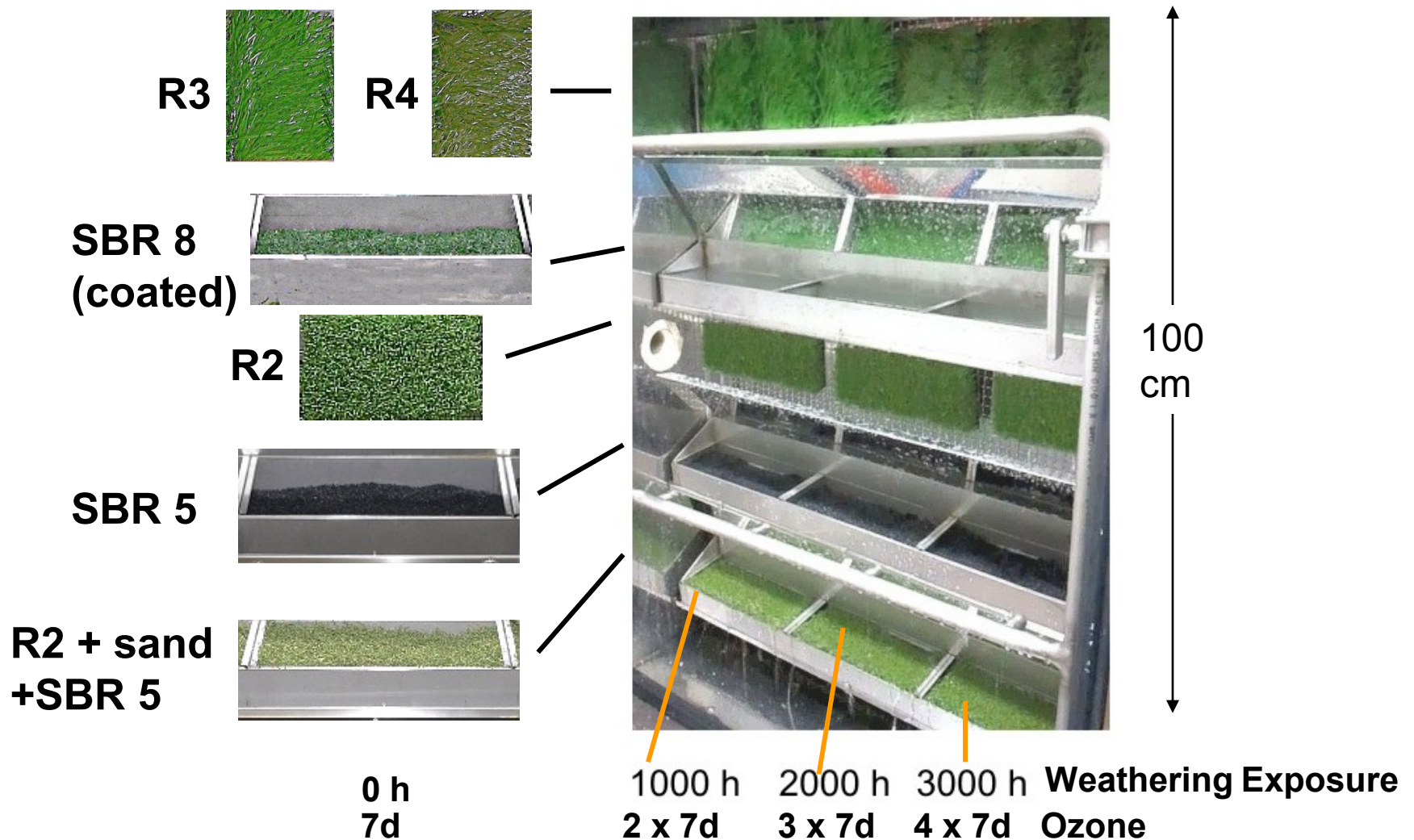
samples for diff.
stages weathered
in parallel

Leaching test on solid samples



Analysis of recycled rain water

Artificial Weathering: Artificial Turf



Artificial Weathering: Artificial Turf: Ozone Test



Ozone conc: 0,5 ppm

Temperature: 30 °C

Humidity 90 %RH

Duration: 7 days

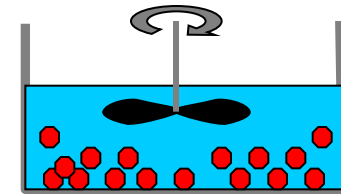
0 h	1000 h	2000 h	2700 h
7 d ozone	14 d ozone	21 d ozone	28 d ozone

Leaching Tests

Newly introduced column test carried out in comparison to other established leaching tests like batch tests

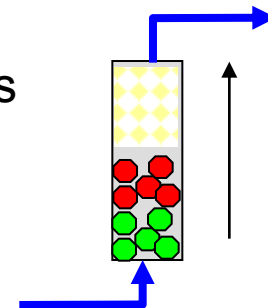
- **Batch test:**

- not realistic, worst case scenarios
- only for single components

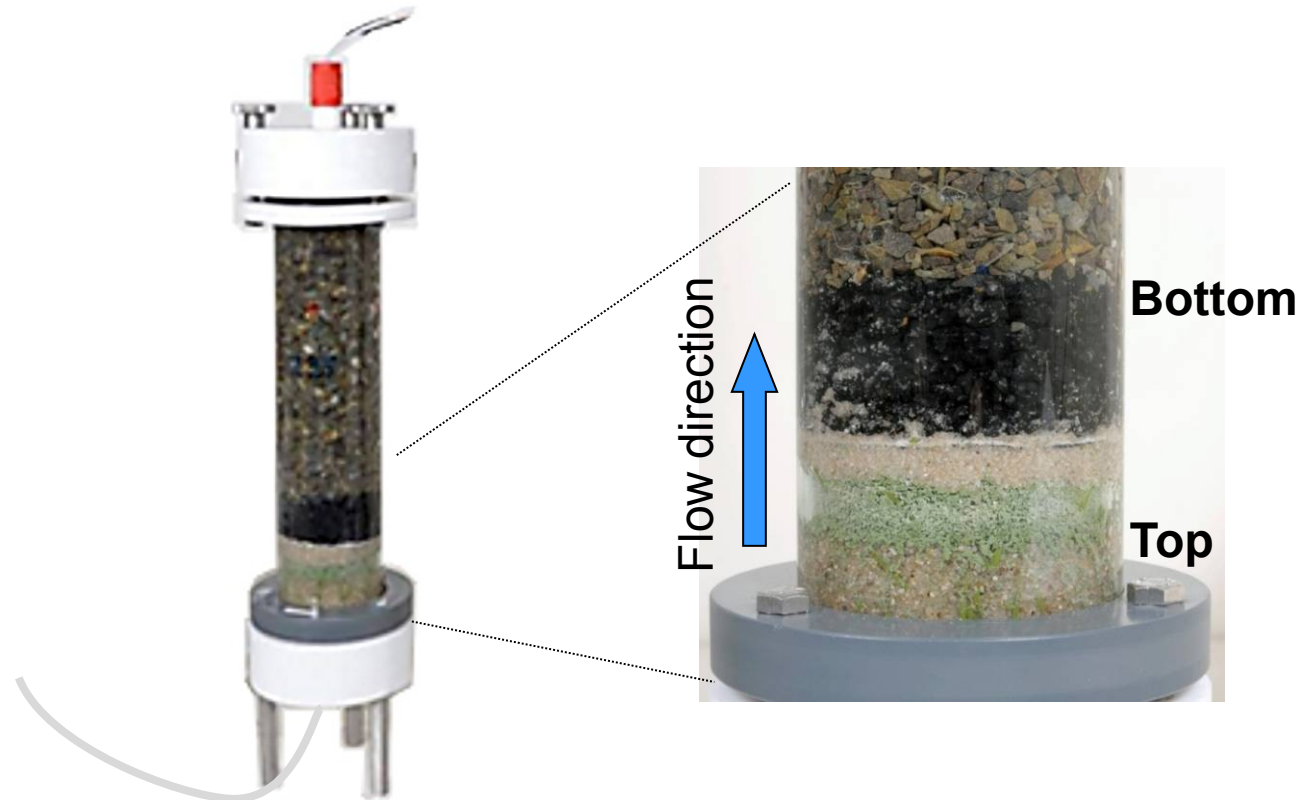


- **Column test:**

- realistic simulation of the actual percolation process
- allows to test entire systems



Leaching Behaviour: Column Test



Elution continued until water / solid ratio = 4 l / kg

Analysis of Eluates

- those with special significance
 - Inorganic Ions: Zn + others: by ICP-OES, GF-AAS
 - Total Organic Carbon (TOC): IR detection
 - Polycyclic Aromatic Hydrocarbons (PAH): HPLC-FLD
- additional analyses
 - Total Nitrogen (TN)
 - Elements: by ICP-OES
 - Physical parameters: pH, conductivity, turbidity
 - ...

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Artificial Weathering: Running Tracks



B1

Magnification 20x

0h Weathering

4200 h Weathering



← 8 mm →

B2

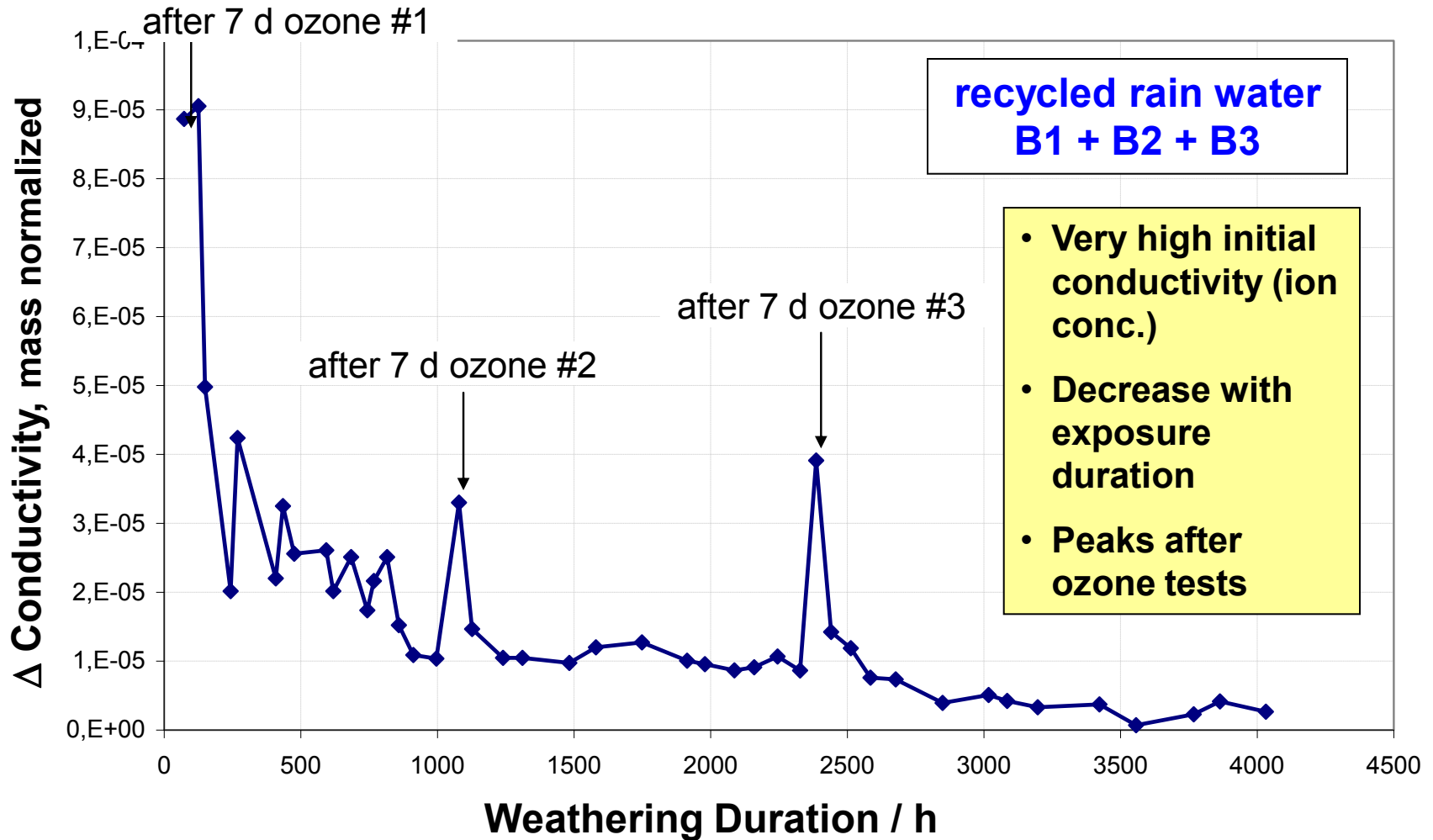
Magnification 20x

0h Weathering

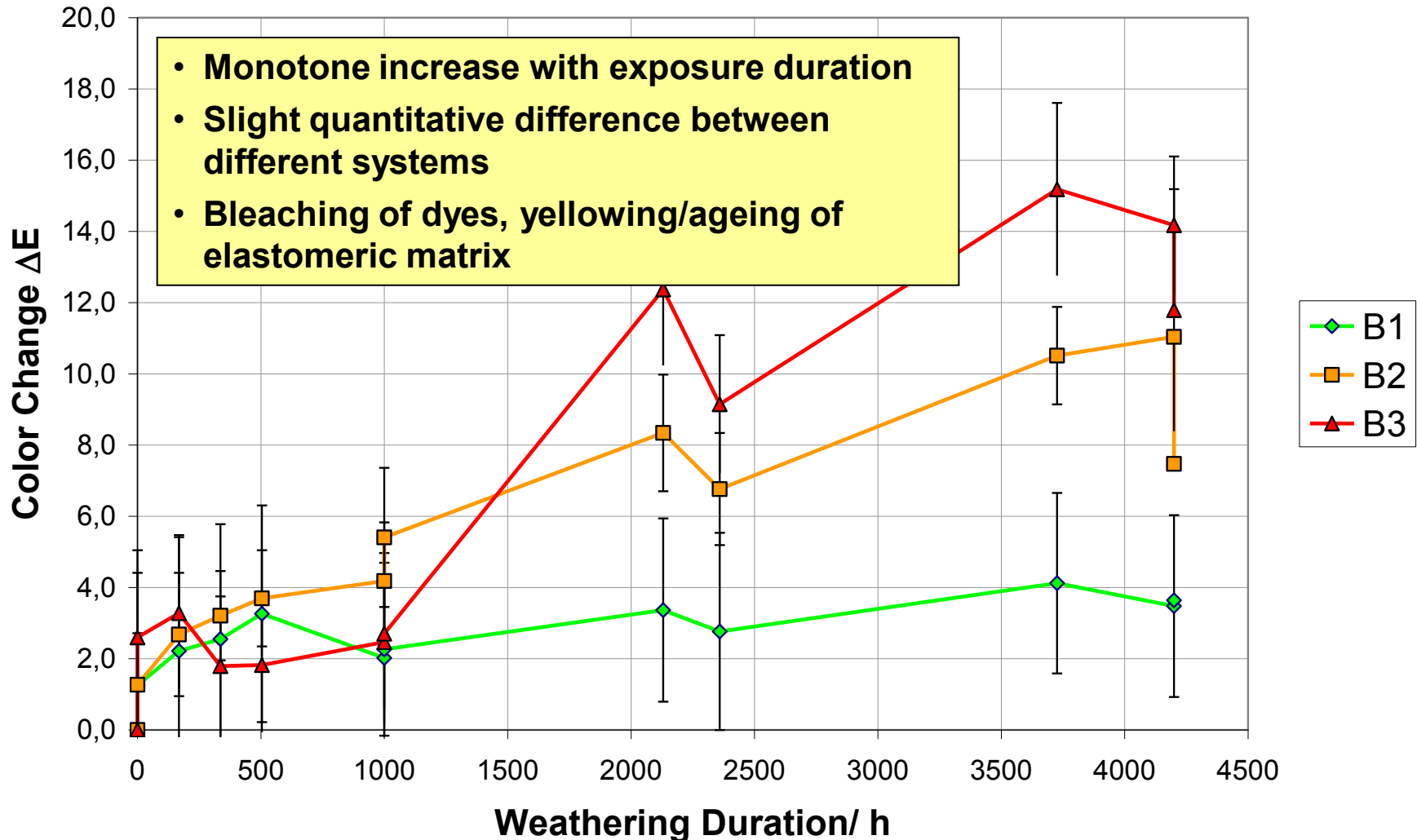
4200 h Weathering



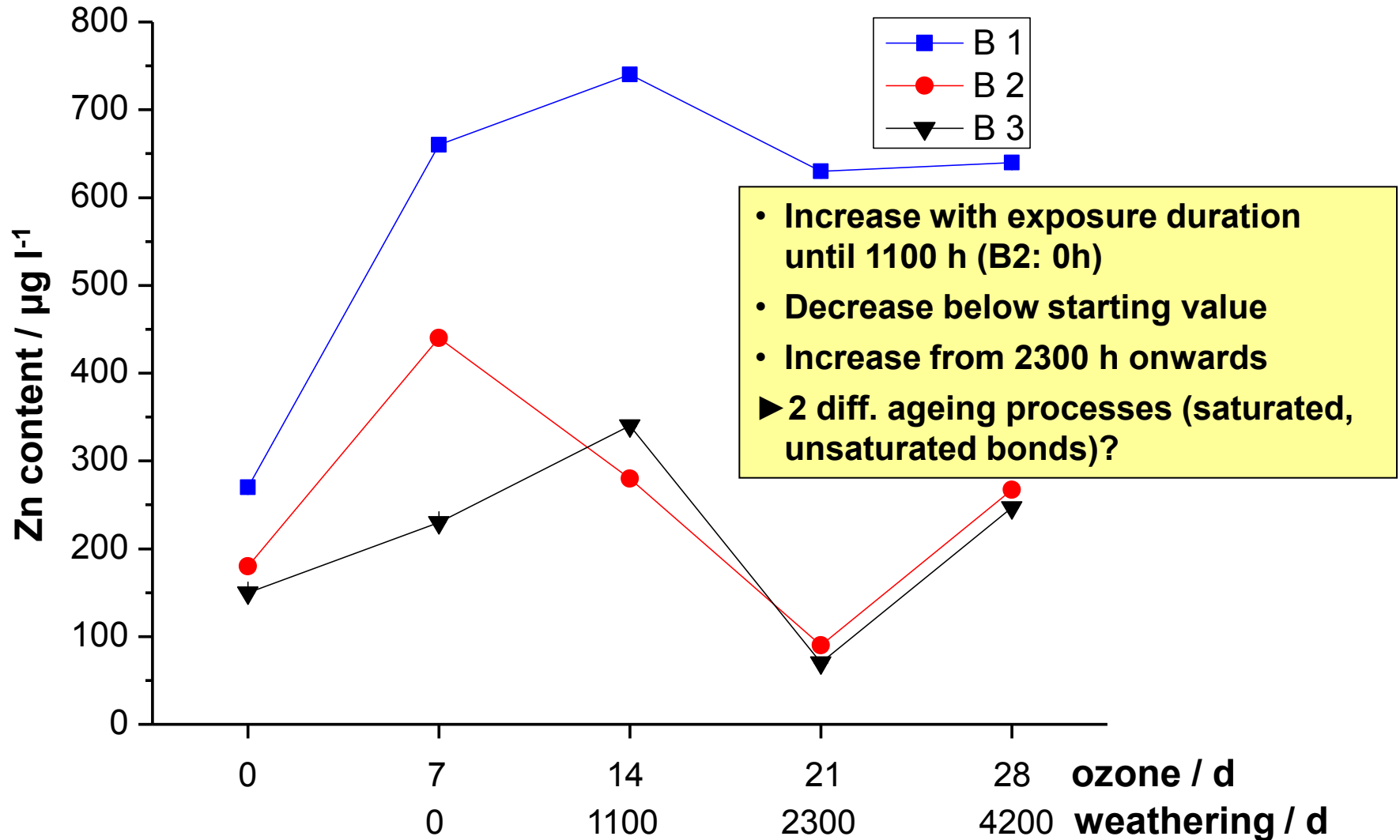
Artificial Weathering: Running Tracks



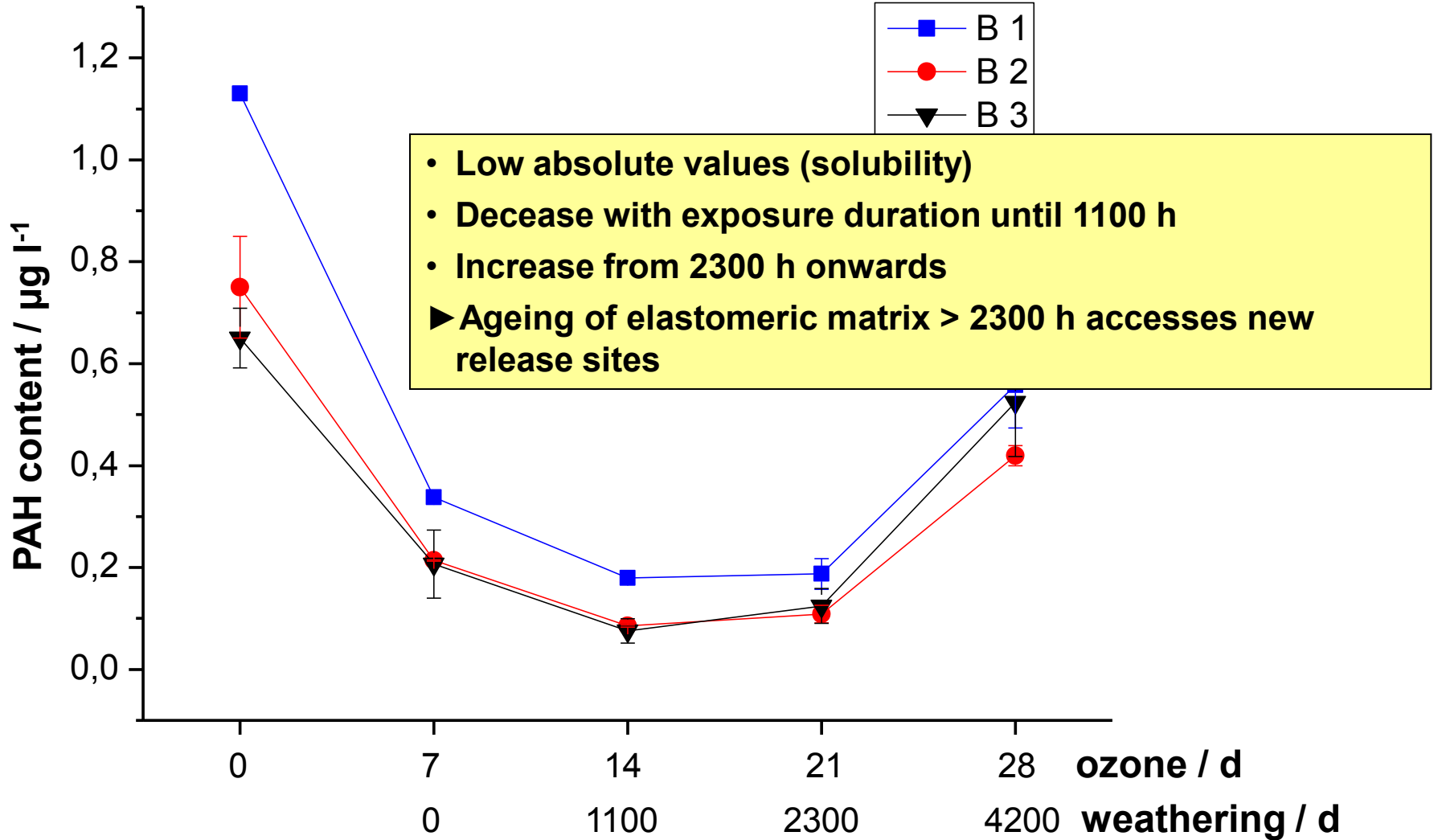
Artificial Weathering: Running Tracks



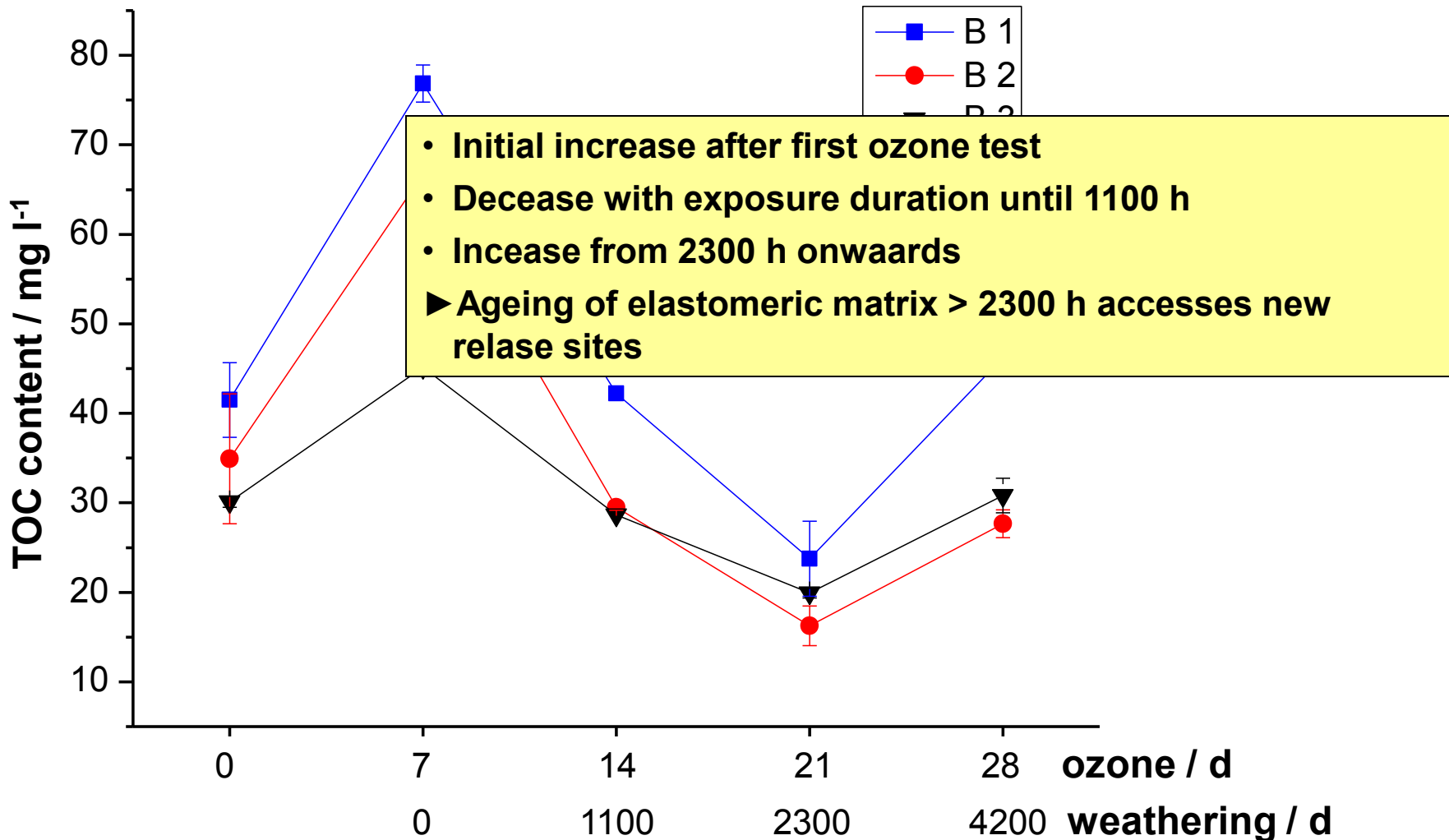
Artificial Weathering: Running Tracks



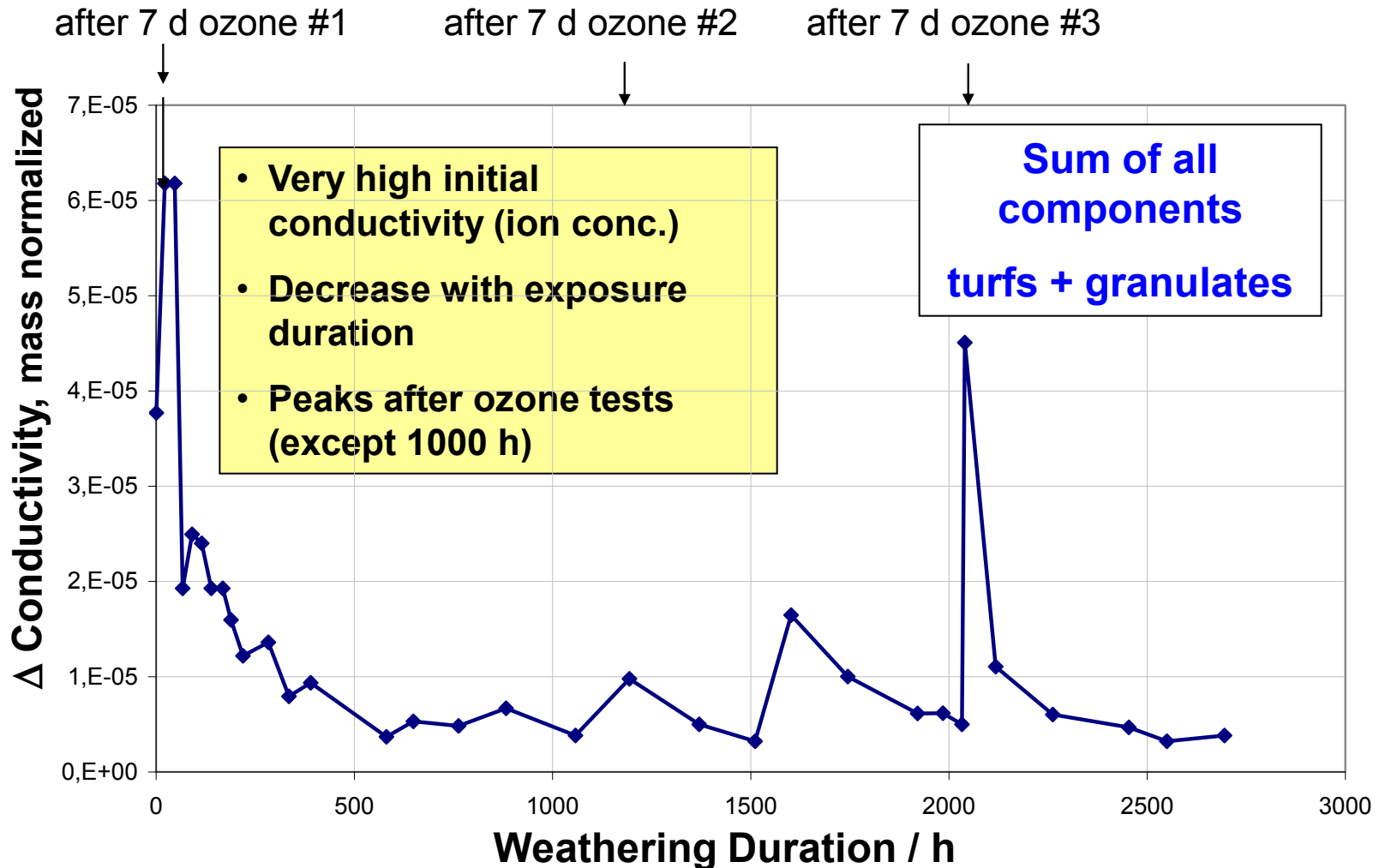
Artificial Weathering: Running Tracks



Artificial Weathering: Running Tracks

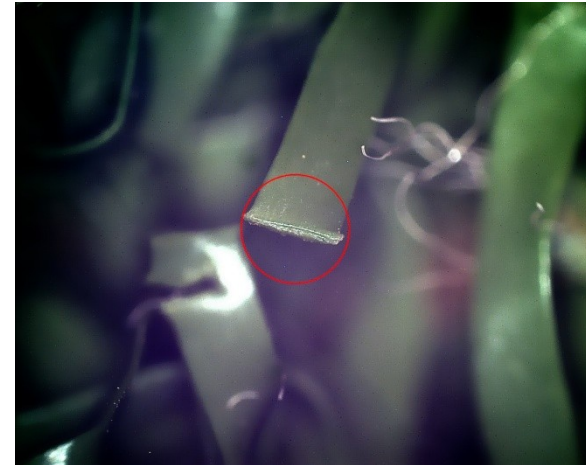


Artificial Weathering: Artificial Turf



Artificial Weathering: Artificial Turf

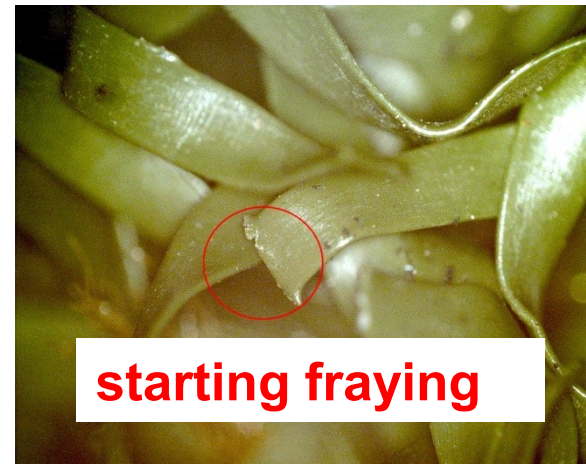
0 h



2700 h



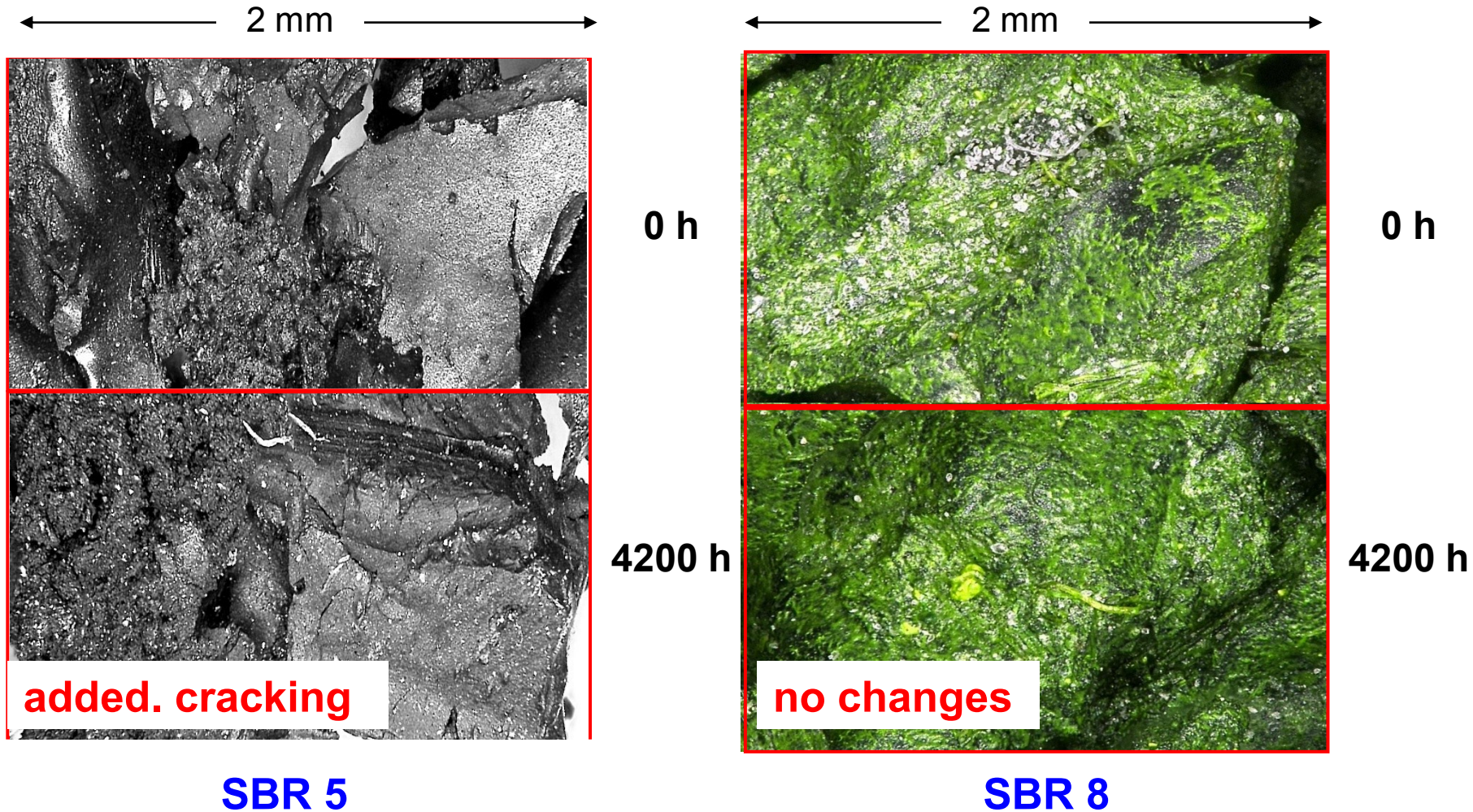
1 mm



starting fraying

7 mm

Artificial Weathering: Artificial Turf



Artificial Weathering: Artificial Turf

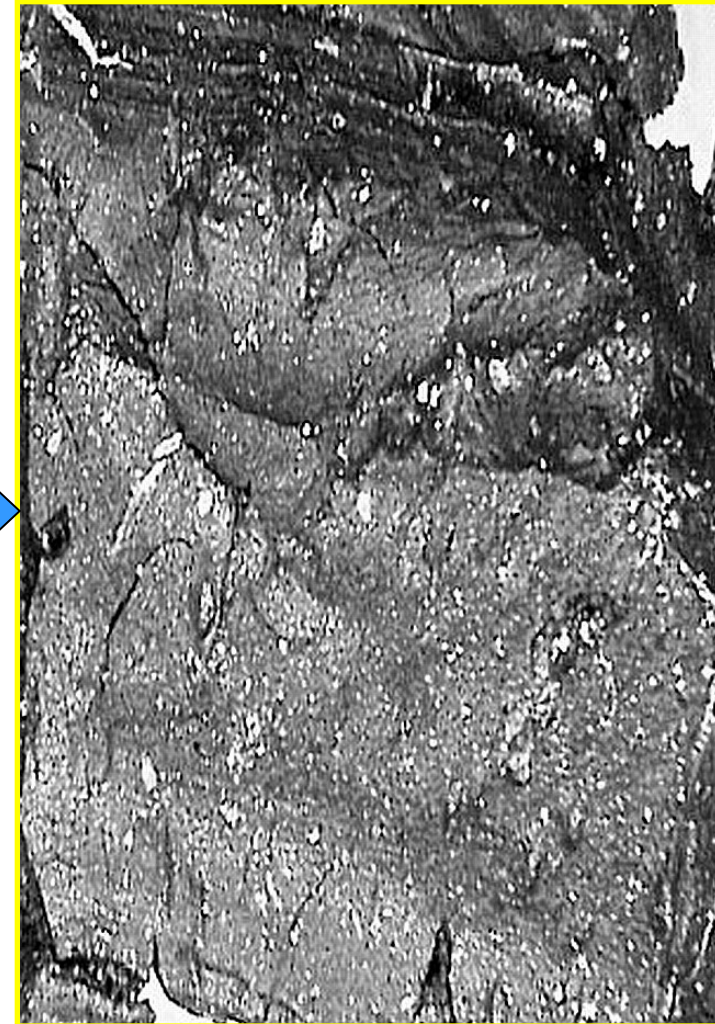
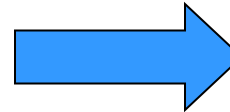
SBR 5

0 h

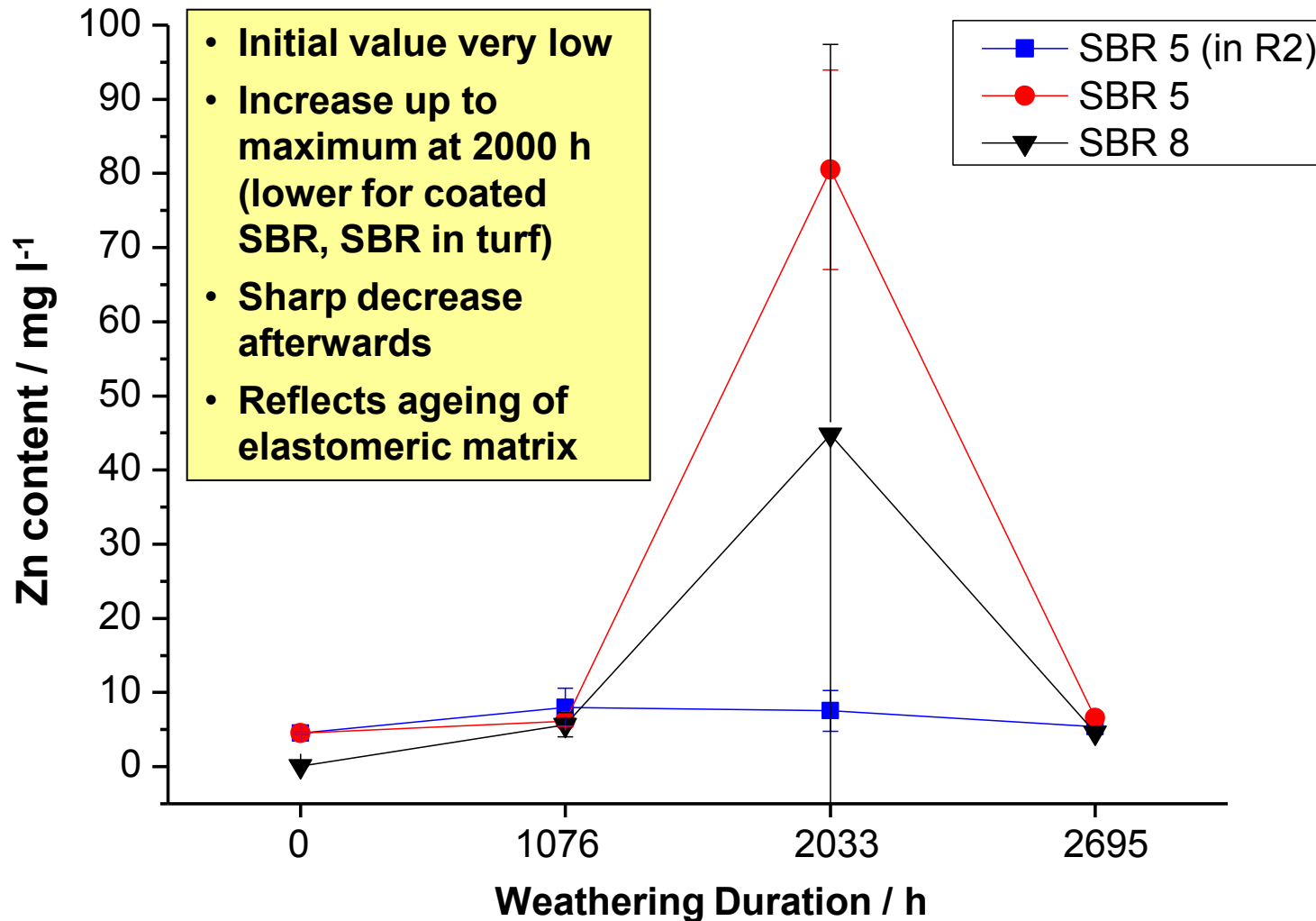


1 mm

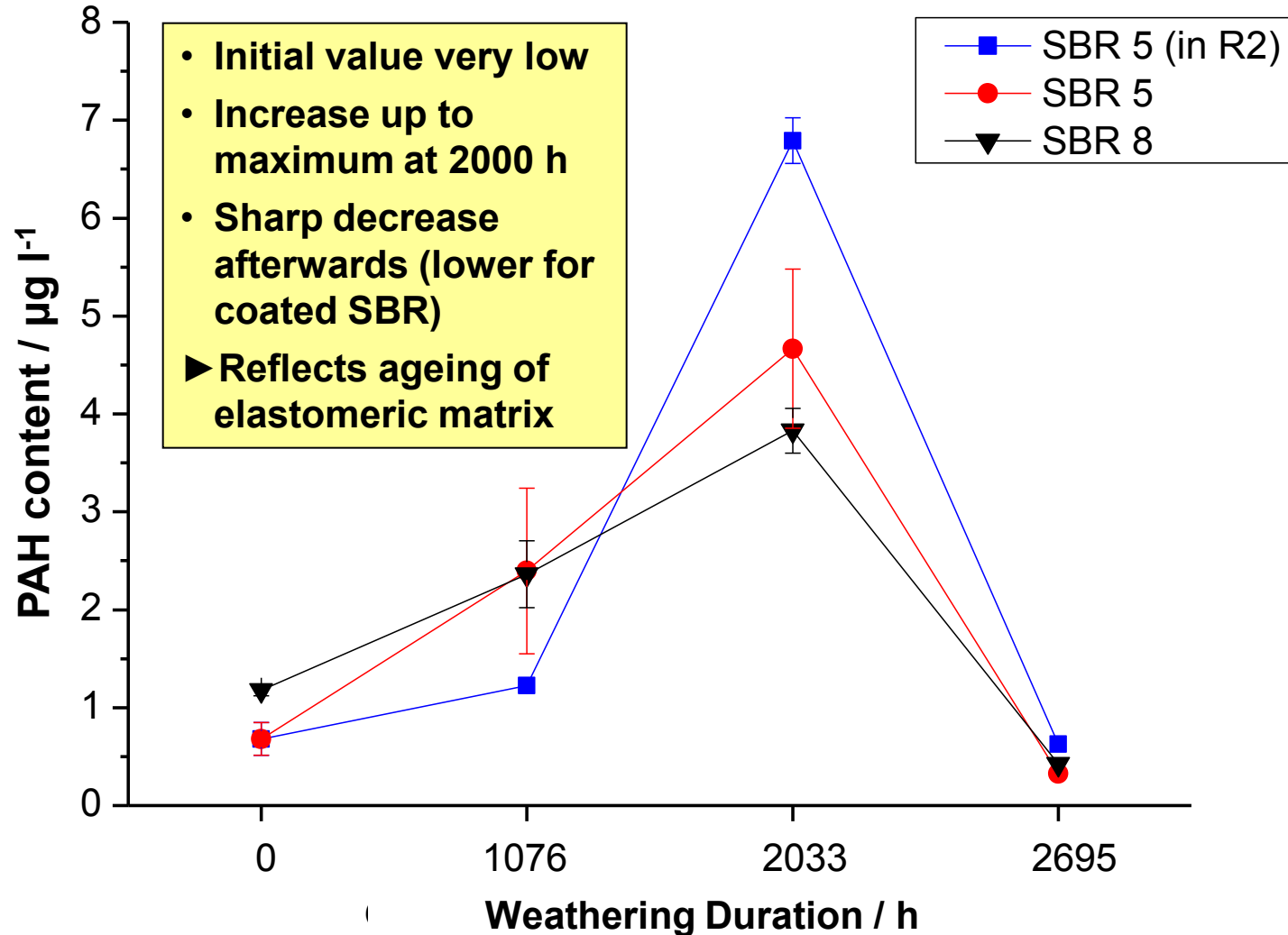
4200 h



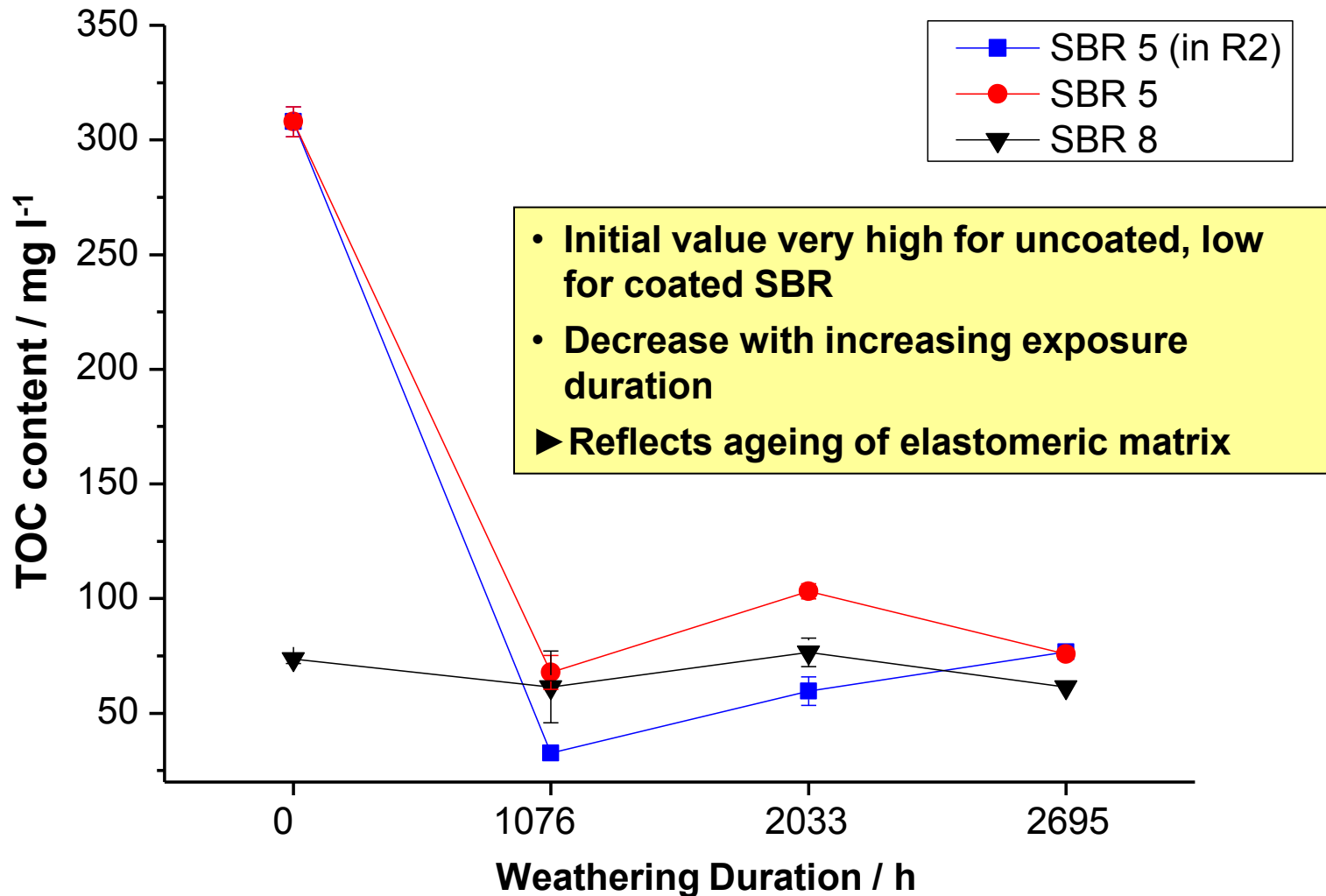
Artificial Weathering: Artificial Turf



Artificial Weathering: Artificial Turf



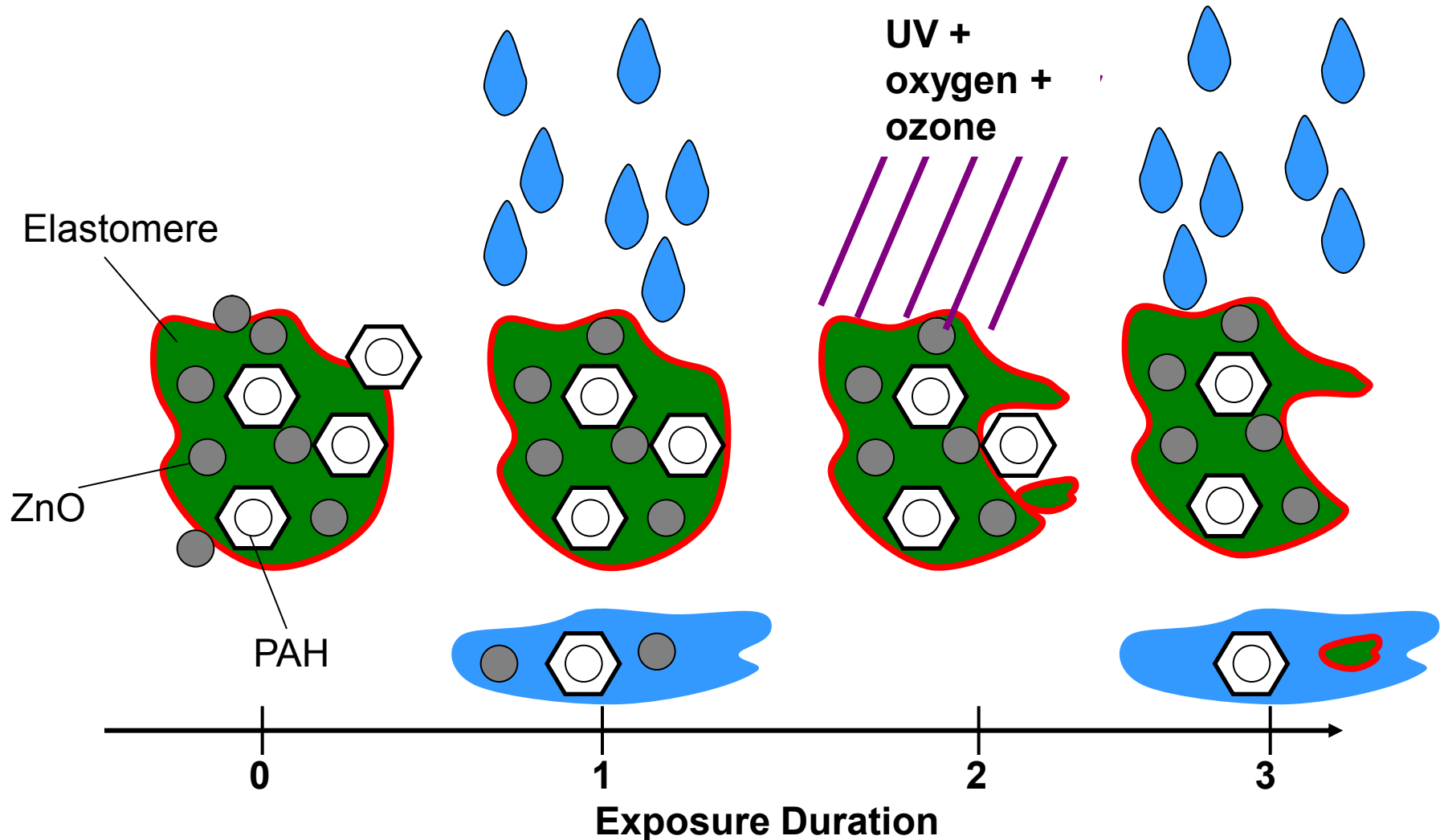
Artificial Weathering: Artificial Turf



1. Introduction
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- **Contribution to leaching: rubber >> polyolefins**
- **Complex leaching behaviour as function of weathering time:**
 - each component shows specific ageing behaviour
 - each leached species shows different ageing behaviour
 - each component has different leaching behaviour
 - observed behaviour of sample is sum behaviour of components
- **Time/ageing scale of leaching per component**
 - unbound material on surface is dissolved
 - recycled/aged material releases in further ageing process more and more blended additives and fillers from newly ageing exposed material
 - ozone:
 - unsaturated C=C bonds → ozonolysis
 - saturated C-C bonds → oxidation

Schematics of Ageing Behaviour of Leaching



Thanks !