(Artificial) Aging of Synthetic Turf

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Comparative Examinations under Different Weathering Conditions

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Most relevant European Documents and Standards concerning Artificial Weathering

- CEN/TC 217/WG6 N 560 (9th draft, 2002-12):
  Surfaces for Sports areas
  Synthetic turf for Football, Hockey, Tennis and Multi-Sports
  primarily designed for outdoor use
  Specification

- CEN: prEN 14836: Synthetic surfaces for outdoor sports areas – Method of test – Artificial weathering

- (EN) ISO 4892: Plastics - Methods of exposure to laboratory light sources:
  - Parts 1-4
Content of prEN 14836 – Special Features and Aspects
(based on recent German version)

- Normative References (among others):
  (EN) ISO 4892:
  Plastics - Methods of exposure to laboratory light SOURCES –
  ✷ Part 1: General guidance
  ✷ Part 2: Xenon arc sources.
  ✷ Part 3: Fluorescent UV lamps – (no reference – just forgotten?)
- Principle: Test pieces are exposed to artificial weathering... colour and selected physical properties are determined.
- Light source: UV-A 340 nm lamps
- Exposure Chamber
  ✷ Temperature and irradiation control according to ISO 4892-1
  ✷ Spraying with water or wetting by a humidity condensing mechanism according ISO 4892-2 and –3.
- Exposure conditions (recommended)
  ✷ 4 h dry UV exposure at a black-standard temp. of 55±3 °C
  ✷ 2 h of condensation exposure, without radiation, black stand. temp. 45±3 °C
  ✷ (this cycle is not listed in ISO 4892-3)
- Procedure: No obligatory time or other conditions.
- Measuring / Expression of results
  ✷ Colour changes according to ISO 7724 and ISO 105-A02
  ✷ Physical properties (change in %):
    ● Measures
    ● Tensile strength
    ● Friction
    ● Shock absorption
    ● Vertical (?) Deformation
Discussion of prEN 14836 – Questions

- Some of the main flaws should be eliminated, e.g.:
  - Simply by reference to EN ISO 4892-3
  - Especially the irradiance on the face of the samples must be specified exactly.

- Selection of properties for evaluation
  - Should be left to the relevant specification of the special sports surface.
  - This has been done already in the paper N 560 specifying synthetic turf:
    - Tensile strength (of fibre).
    - Colour fastness
  - Checking other properties (as a criterion) seems to be useless

- Further open questions:
  - Aging of rubber granules
  - Aging of EPDM granules
  - How can we achieve sufficient repeatability of the results?
  - How can we find out the statistical tolerances?
    (which could be extremely high).

- Finally once more the question:
  - Can „perfect“ correlation to natural weathering really be achieved by the UV-A lamps?
  - Or do we need the well-tried and approved Xenon arc?
Outdoor and Artificial Aging of Polymers - Basics

- Main agents of outdoor Aging:
  - Sun light (short-wave UV)
  - Oxygen
  - Heat
  - Water
  - Frost-dew
  - Mechanical stress, abrasion

- Change of material performance:
  - Loss of elongation at break
  - Loss of tensile strength
  - Britleness
  - Increasing abrasion
  - Loss of colour

- Main effects of aging on chemical structure:
  - Oxidation (foto-, thermoxidation)
  - Chain-break and degradation

- Change of sports performance:
  Long-term effect is a consequence of many other factors as well.
Search for test methods for Polyethylene and Polypropylene

These polymers are similar, both are polyolefins.

Aging by weathering is a very complex chemical process and the polyolefins are very sensitive to degradation by UV, oxygen and high temperatures.

Therefore the polymers must have high quality and a high quality UV stabilizer system (including effect of heat).

How can this quality be verified?

By means of an effective and reliable test method taking into account the special structure of the relevant polymers!
Ultraviolet and Visible Part of Sunlight

![Graph showing spectral irradiance vs. wavelength for UV and visible light areas.]
Spectral Irradiance of Xenon Arc Lamps

- Sunlight
- Filtered Xenon arc irradiance

Spectral irradiance [W/m²/nm]

Wavelength [nm]

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Spectral Irradiance of Fluorescent UV-Lamps

Sunlight

UVA-340

UVB-313
Principle of UV-Weathering Device
Effects of Brittleness Caused by Outdoor Weathering

PE-HD slab: 9 years exposed in Vienna

PP-Films with different stabilizers.
Exposed 450 days in Vienna.
Start: Summer

Results of tensile strength tests
Artificial Aging of PP-Fibres in QUV-Chamber
IST - Kolitzus

Direct exposure of separated fibres showed damage – as on site
Artificial Weathering of Polypropylen Materials: Change of Tensile Strength

- Xenon arc lamps, material 1
- Fluorescent lamps, material 1
- Xenon arc lamps, material 2
- Fluorescent lamps, material 2
- Xenon arc lamps, material 3
- Fluorescent lamps, material 3
- Xenon arc lamps, material 4
- Fluorescent lamps, material 4
Artificial Weathering of Polypropylene Materials: Change of Elongation at Break

![Graph showing change of elongation at break over duration of radiant exposure for different materials under different lamp types.]
Artificial Weathering of Synthetic Turf: Austrian Test Method

- Preparing of fibres for tensile test specimens (if necessary glued between acrylic clamps)

- Artificial aging (7500 MJ/m²) according to
  - DIN 53 387 (ISO 4892-2)
  - (EN ISO 4892-3 ?)

- Tensile strength tests according to EN 13864

- Requirements for elongation at break and strength:
  - Retained values ≥ 50 % (of initial values)
  - (Colour fastness: ≥ 3 grey scale)
PTFE

Requirements for the test method concerned:

- High acceleration by artificial weathering
- Good correlation to outdoor weathering
- Good quantifiable results of damages by artificial weathering
- Cost effectiveness
Weathering Chamber Fitted w/ Xenon Arc Lamps
Which light source for artificial weathering?

- The main problem is a good balance of A and B. The „heart“ of every weathering device is the „artificial sun“ - most successful examples:
  - Xenon arc *)
  - UV fluorescent lamp *)
  - Carbon arc lamp
  - Metal halide emitter.

- For plastics, there is sufficient experience with these two *) light sources only.
Labosport – internal study for tropic islands

Good correlation between the results on site (8 month) and artificial aging

<table>
<thead>
<tr>
<th>Study Nr.</th>
<th>Appearance</th>
<th>Tensile strength</th>
<th>Calorimetry</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Force (N)</td>
<td>Losses (%)</td>
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<tr>
<td>1</td>
<td>Fibrillée</td>
<td>53.2</td>
<td>-27.6</td>
</tr>
<tr>
<td>2</td>
<td>Fibrillée</td>
<td>42.0</td>
<td>-32.7</td>
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<tr>
<td>3</td>
<td>Fibrillée</td>
<td>26.3</td>
<td>-25.6</td>
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<tr>
<td>4</td>
<td>Fibrillée</td>
<td>34.1</td>
<td>-29.4</td>
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<tr>
<td>6</td>
<td>Fibrillée</td>
<td>26.6</td>
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<tr>
<td>9b</td>
<td>Fibrillée</td>
<td>7.3</td>
<td>-17.3</td>
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<tr>
<td>9a</td>
<td>Monofil</td>
<td>6.0</td>
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<tr>
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<td>10</td>
<td>Monofil</td>
<td>16.4</td>
<td>-75.8</td>
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</table>

<table>
<thead>
<tr>
<th>Fibers after ageing (UV B lamps)</th>
<th>2 500 hours</th>
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</thead>
<tbody>
<tr>
<td>Force at break in N (after ageing)</td>
<td>losses related to the force before ageing</td>
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<tr>
<td>Melting point : difference between the temperature after and before ageing</td>
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