ISSS Technical Meeting Vienna 2004

(Artificial) Aging of Synthetic Turf

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XXIII Colloquium of Danubian Countries on Natural and Artificial Ageing of Polymers

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?)
- **Pinciple:** 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

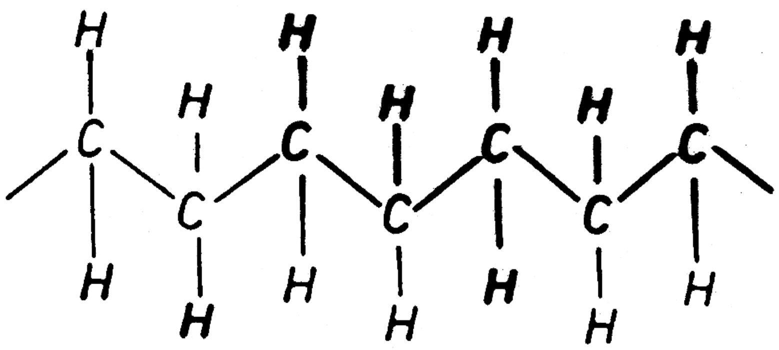
- **Main agents of outdoor Aging**:
  - **Sun light (short-wave UV)**
  - **Oxygen**
  - **Heat**
  - Water
  - Frost-dew
  - Mechanical stress, abrasion
- **Main effects of aging on chemical structure**
  - **Oxidation (foto-, thermoxidation)**
  - **Chain-break and**
  - **degradation**

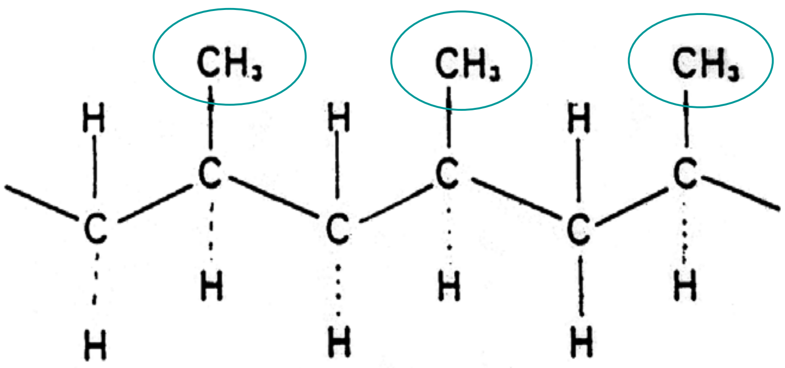
- **Change of material performance**
  - Loss of elongation at break
  - Loss of tensile strength

  → **brittleness**
  → **increasing abrasion**

  - **Loss of colour**
- **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 senitive to degredation 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 !

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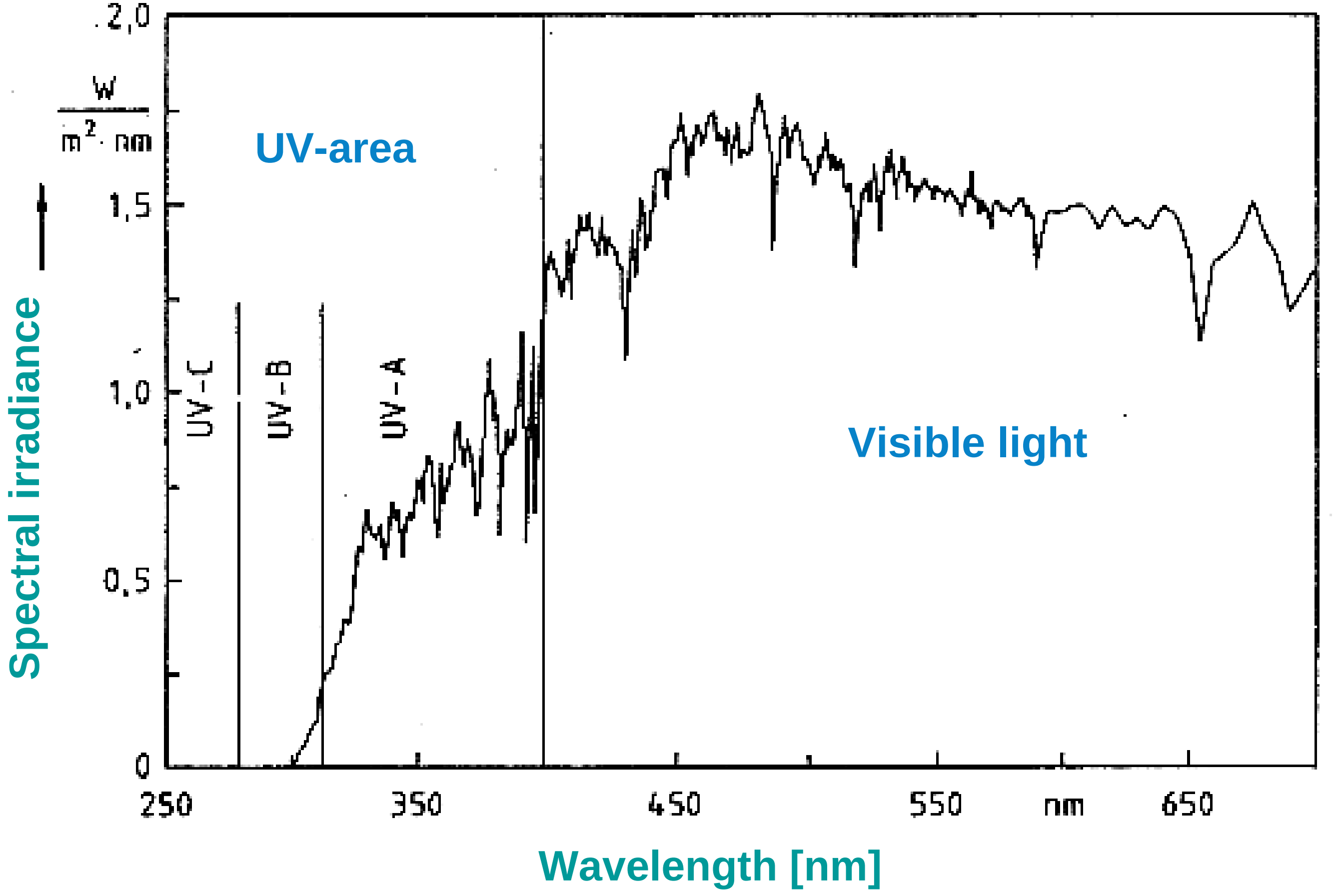
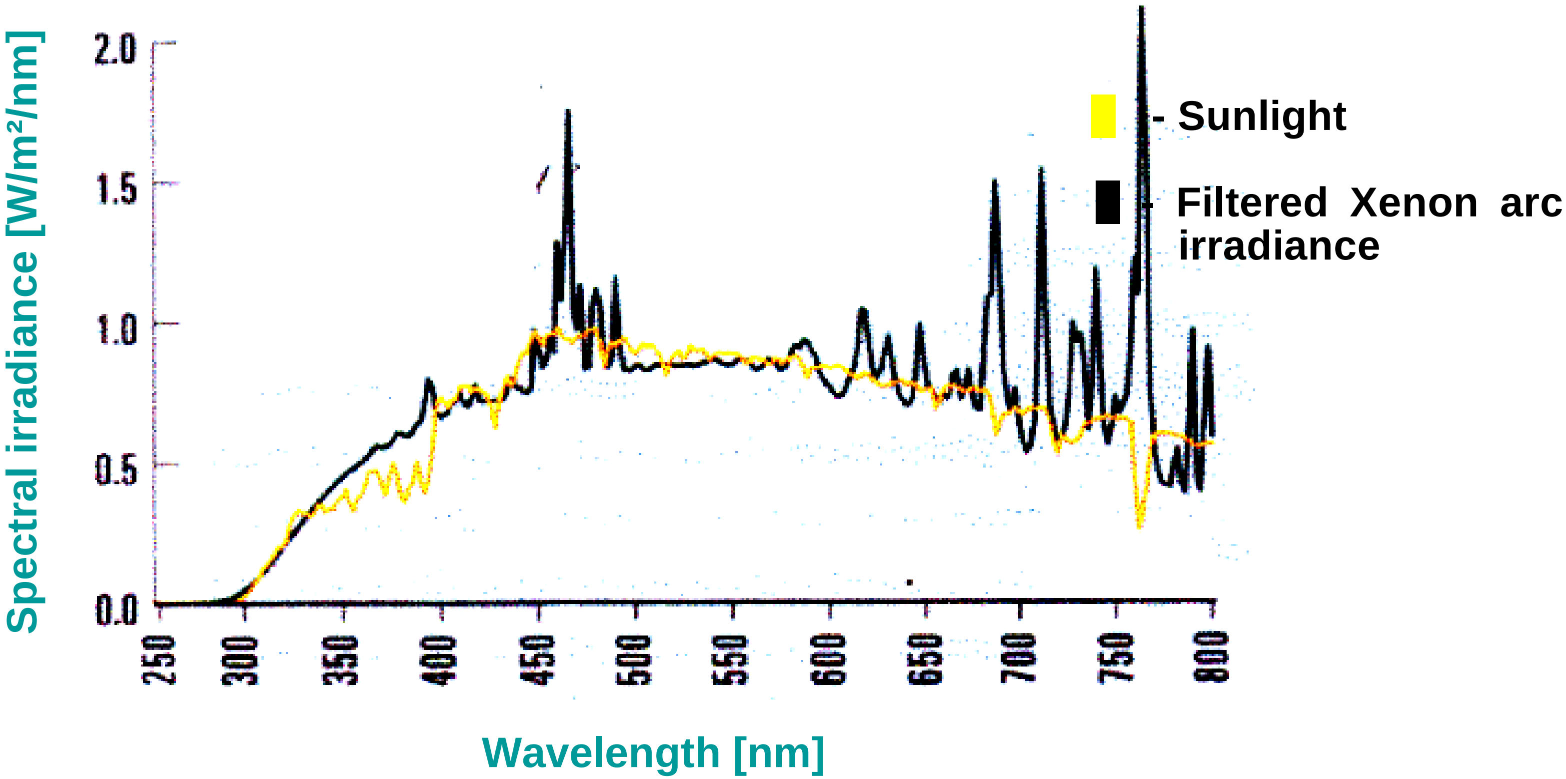
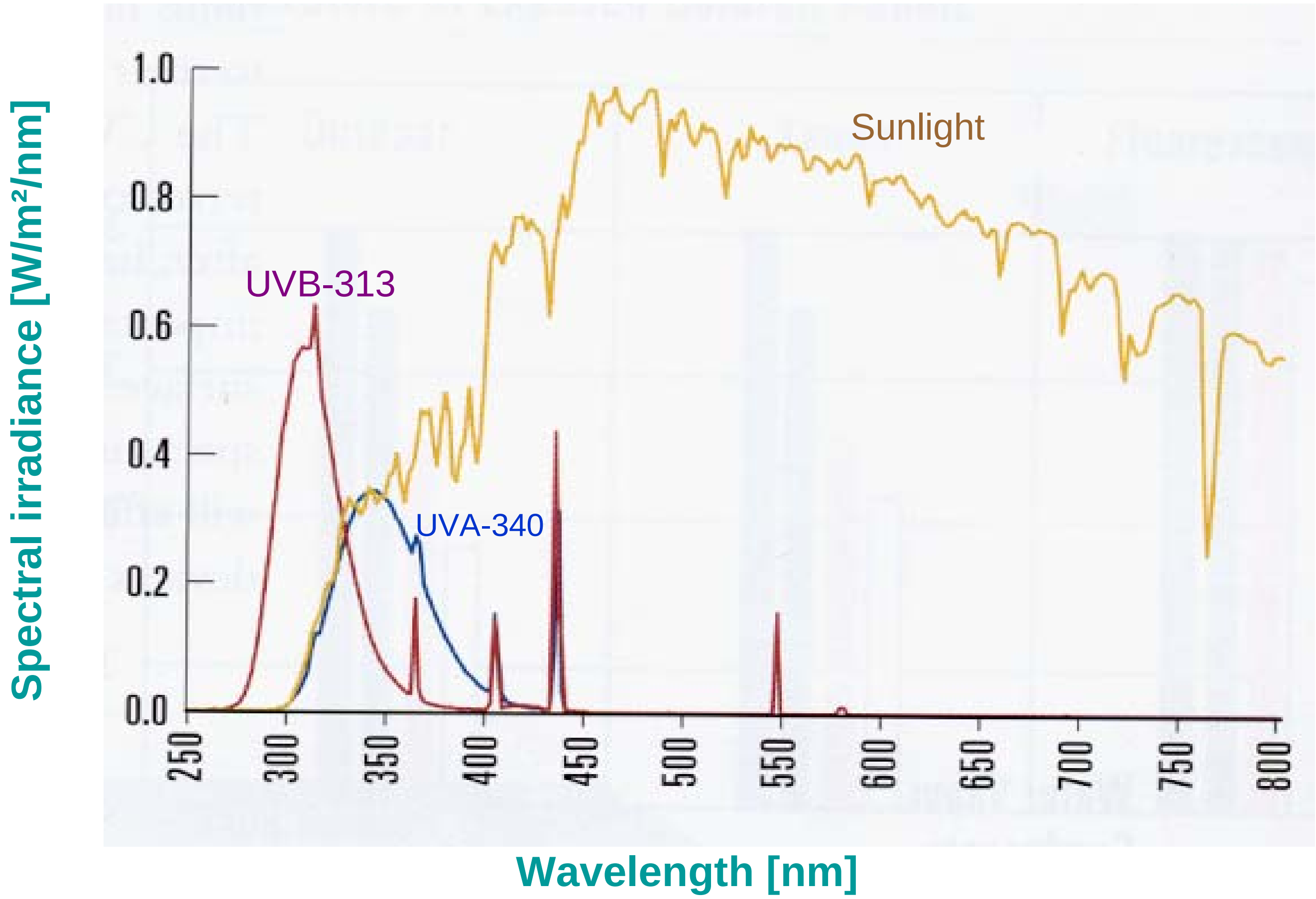
Ultraviolet and Visible Part of Sunlight



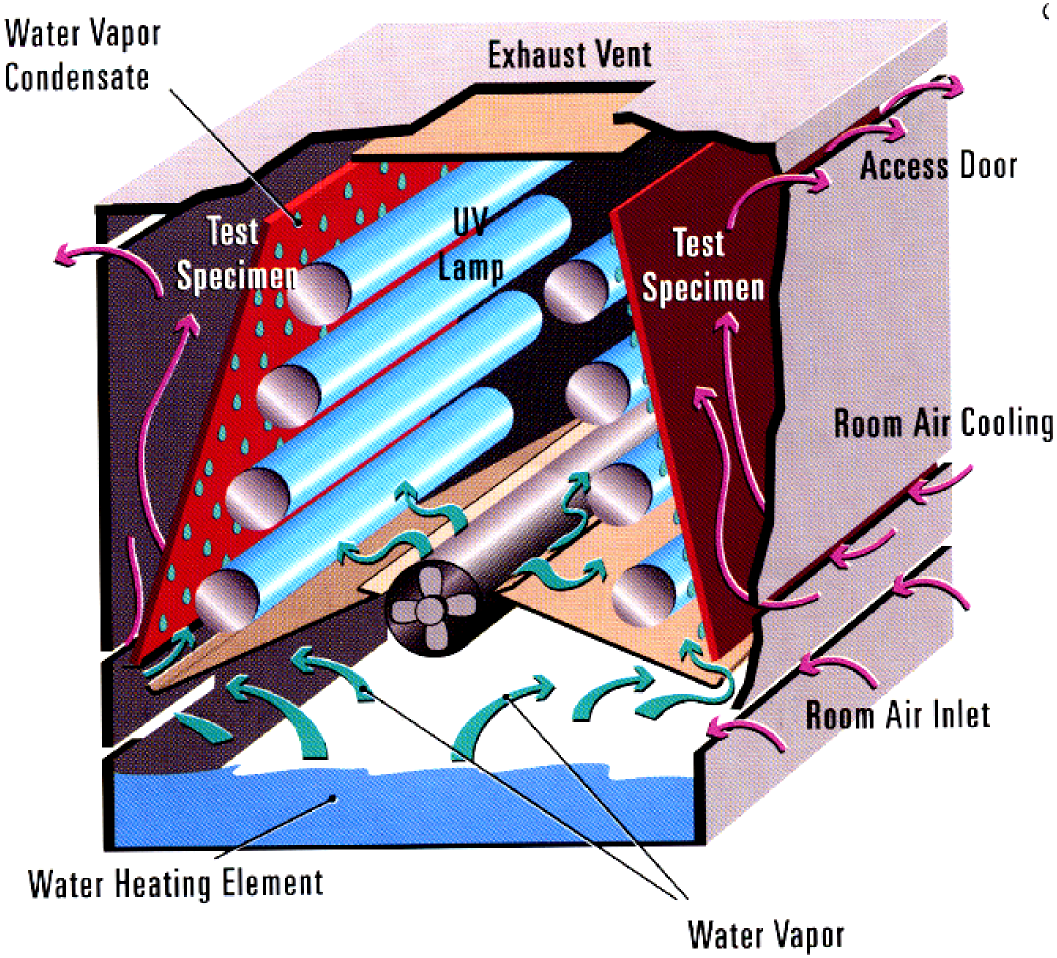
Spectral Irradiance of Xenon Arc Lamps



Spectral Irradiance of Fluorescent UV-Lamps

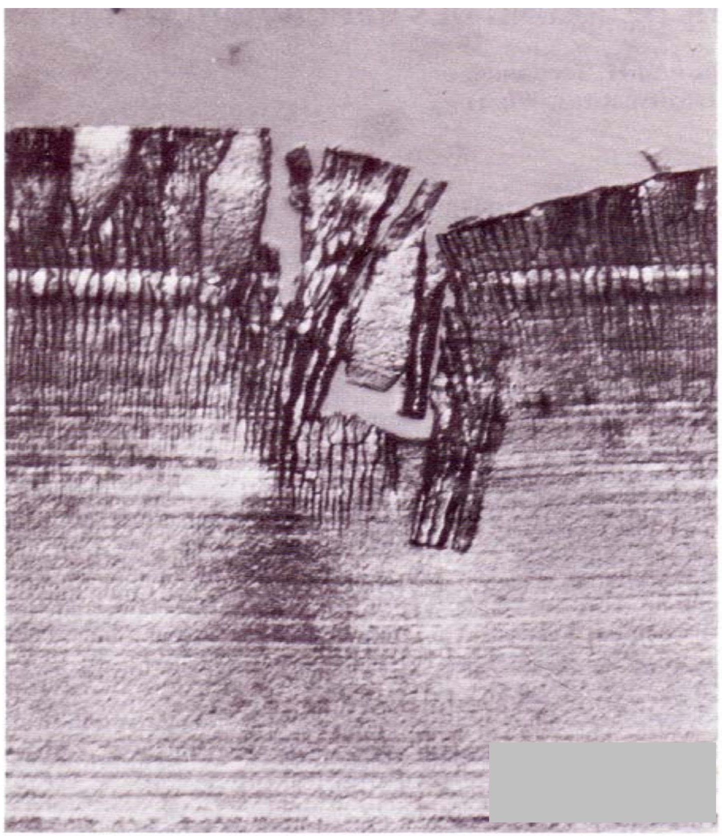


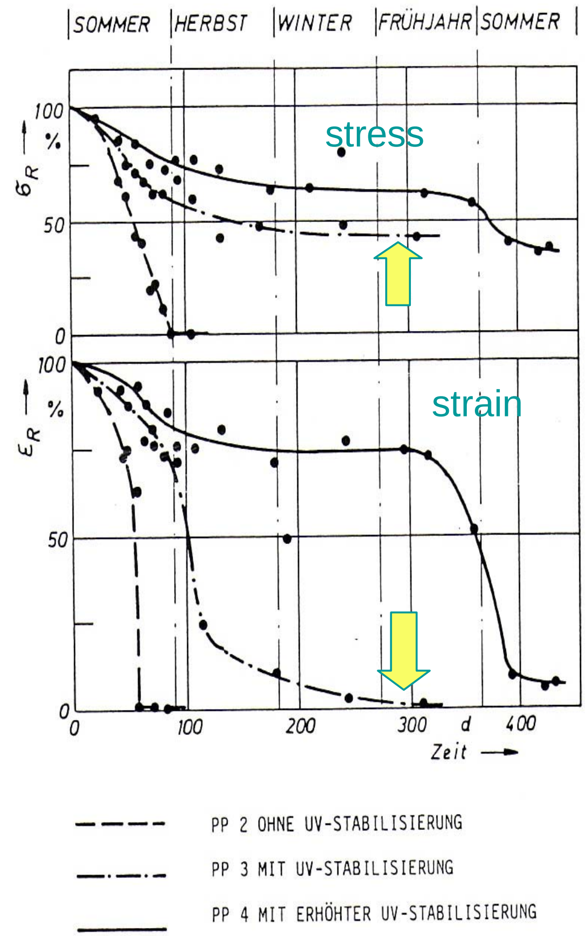
Principle of UV-Weathering Device



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.

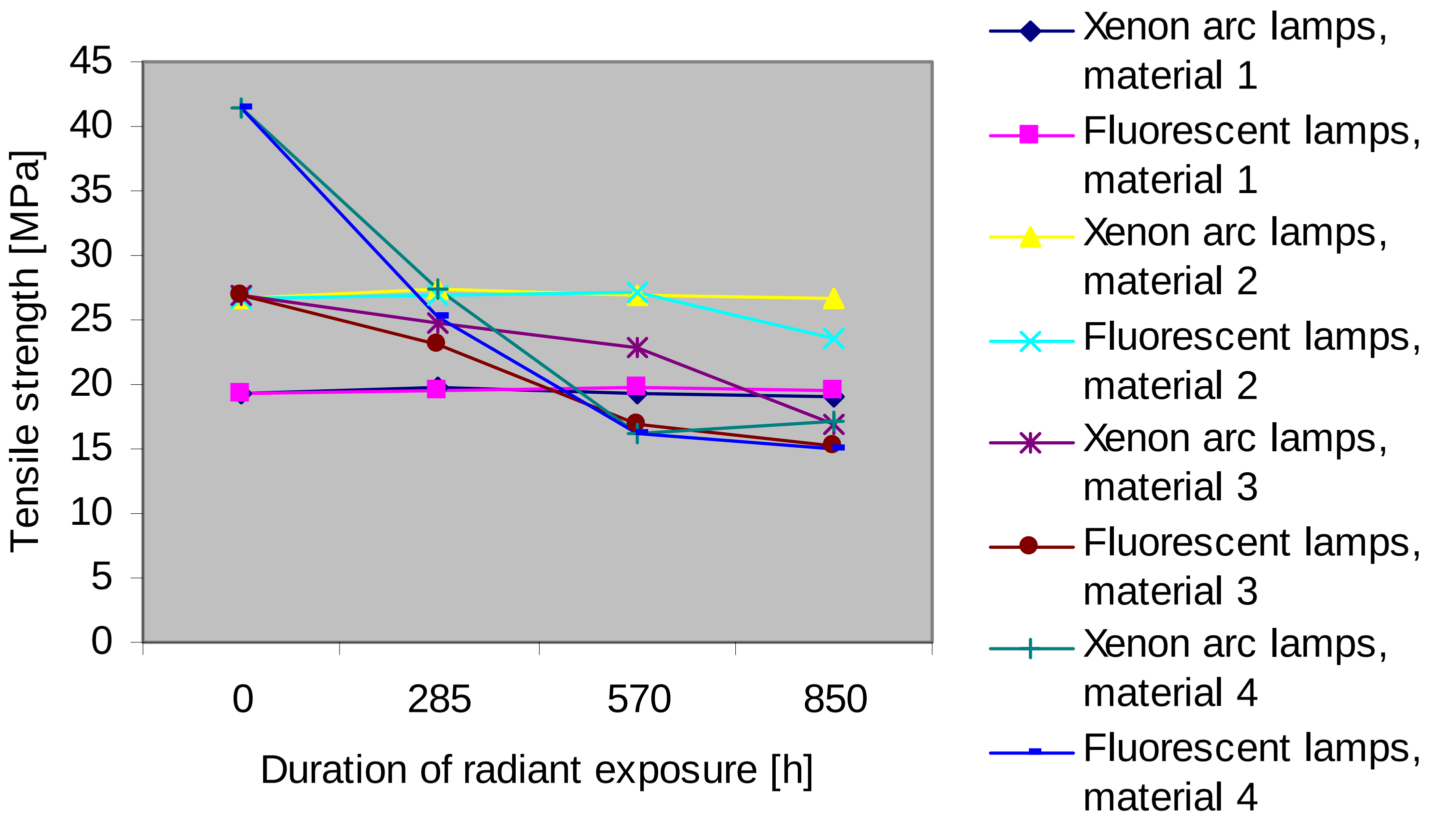
Start: Summer

Results of tensile strength tests

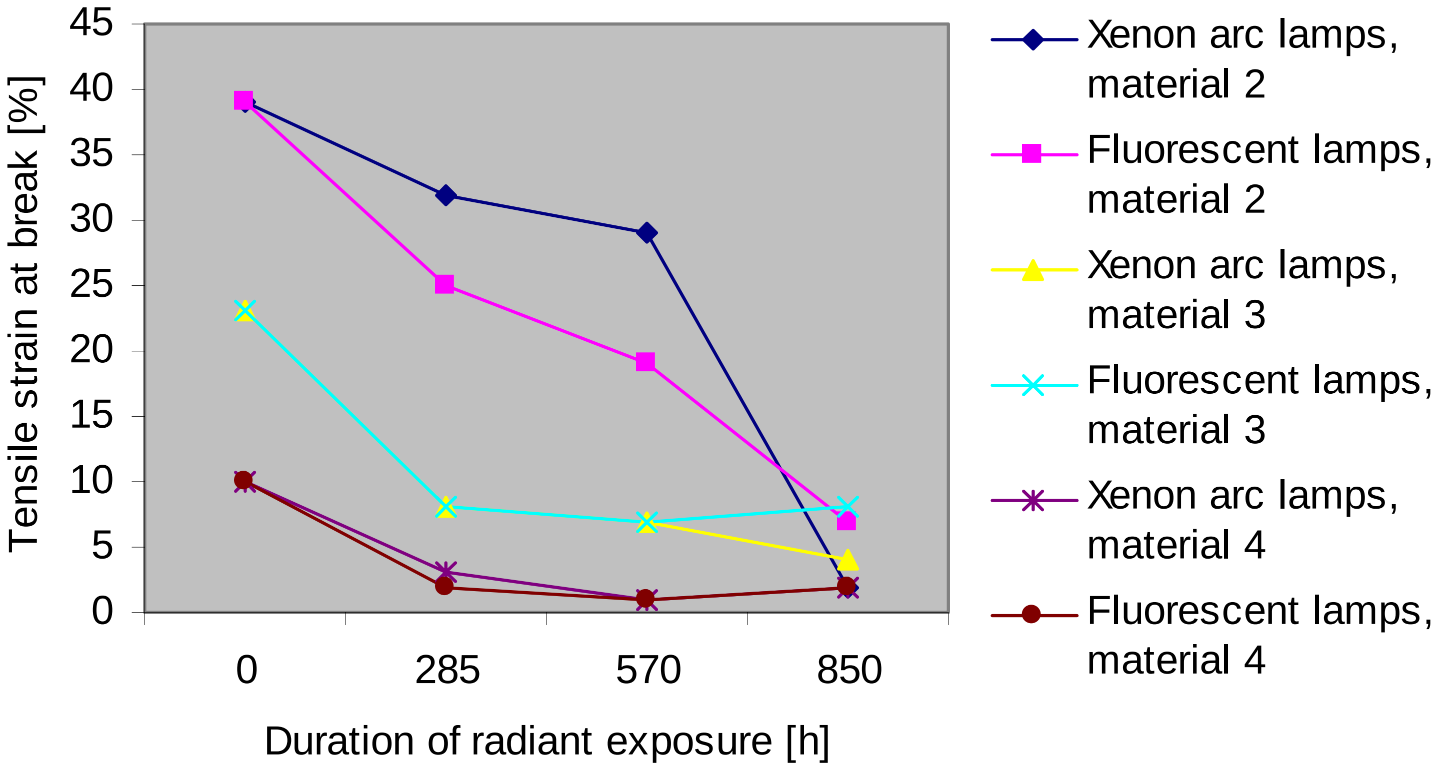
Artificial Aging of PP-Fibres in QUV-Chamber
IST - Kolitzus

Direct exposure of separated fibres showed damage – as on site

Artificial Weathering of Polypropylen Materials: Change of Tensile Strength



Artificial Weathering of Polypropylen Materials: Change of Elongation at Break



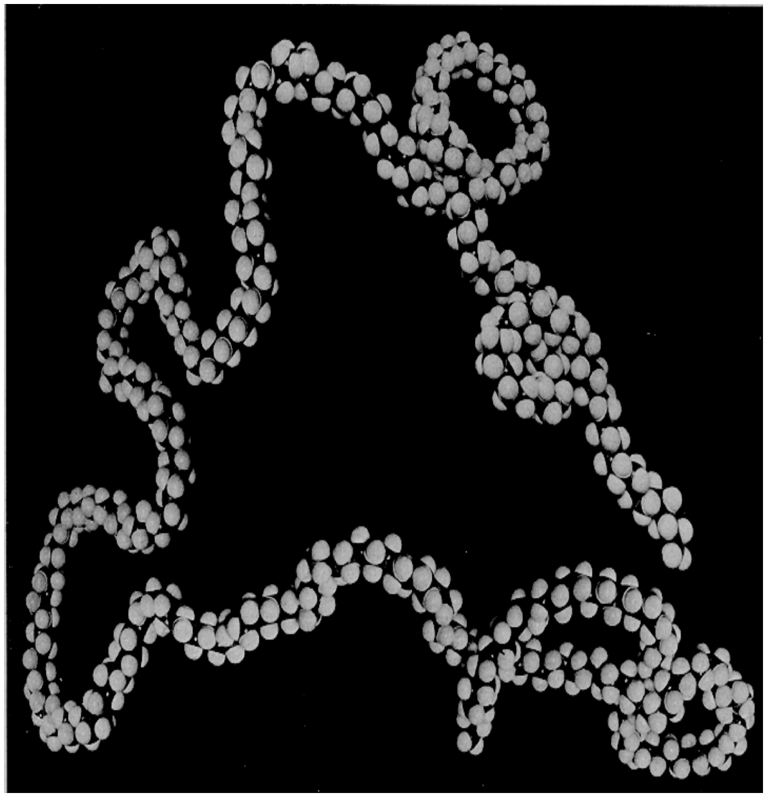
Artificial Weathering of Synthetic Turf:
Austrian Test Method

- 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

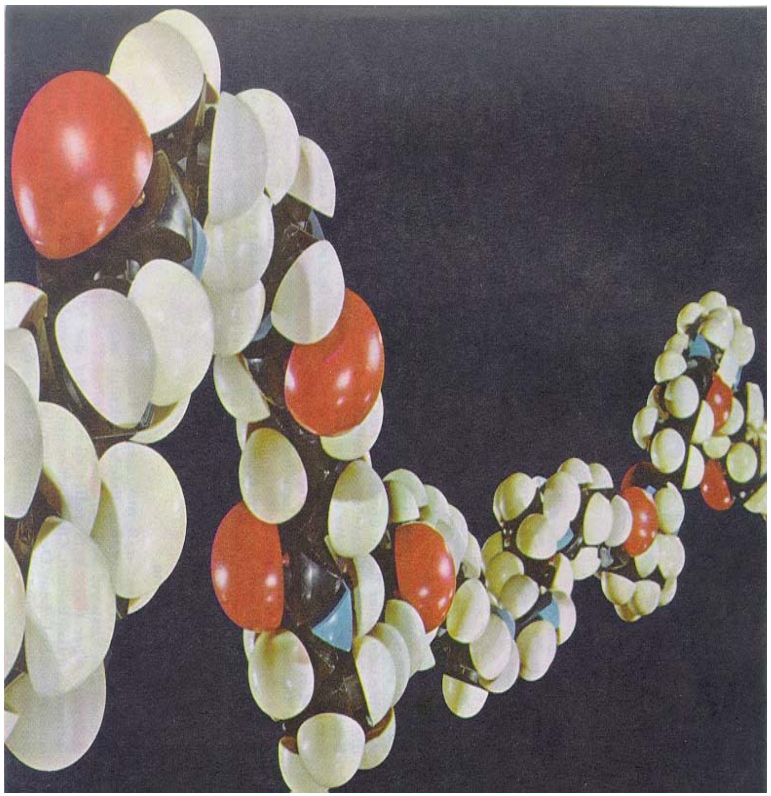


PE-HD Space filling model

- 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 ?



PA-6.6 Space filling model

- 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

			Tensile strength		Calorimetry
	Study Nr.	Appearance	Force (N)	Losses (%)	Melting heat (°C)
Polyethylen	1	Fibrillée	53.2	**-27.6**	**-0.3**
	2	Fibrillée	42.0	**-32.7**	**-0.9**
	3	Fibrillée	26.3	**-25.6**	**0.0**
	4	Fibrillée	34.1	**-29.4**	**-0.8**
	6	Fibrillée	26.6	**-24.3**	**-0.2**
	9b	Fibrillée	7.3	**-17.3**	**-0.4**
	9a	Monofil	6.0	**-43.9**	**-0.9**
Copolymer	5	Monofil	13.8	**-58.1**	**-2.7**
	7	Monofil	11.1	**-57.1**	**-2.8**
	8	Monofil	13.9	**-72.6**	**-4.5**
	10	Monofil	16.4	**-75.8**	**-4.2**
Fibers after ageing (UV B lamps)			2 500 hours		
Force at break in N (after ageing)					
losses related to the force before ageing					
Melting point : difference between the temperature after and before ageing					