MATERIAL TESTS FOR OUTDOOR AREAS

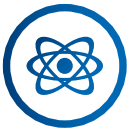
FLEXIBLE AND ROBUST IN ALL ELEMENTS

Barthelme
LED Solutions

CONTENTS

QUALITY.

KNOWLEDGE.



INNOVATION.

FLEXIBILITY.

DEDICATION.

85

SINCE 1931

Barthelme

LED Solutions

FOREWORD

We are convinced, that the quality and value of our work is reflected in our innovations and products.

Today and tomorrow.

In this year, Barthelme is celebrating an anniversary: 85 years of successful activity in the lighting market, characterized by innovation, expertise and customer specific solutions.

Barthelme has been focusing on LED solutions for more than 20 years. Initially this focus was concentrated in the industrial field but since 2001 we have been moving more and more into the general lighting business. In the middle of the previous decade we began testing the protection of our LED luminaires against environmental influences, thereby make them capable of being installed in a wider range of applications - amongst other in outdoor areas.

Initially we worked with laquers to protect the electronics from moisture. However, the increased national and international demand for new and higher protection classes led us to use silicone and epoxy in our profile luminaires to make them robust for outdoor applications. The consequence was that flexible LED concepts without profiles were no longer possible due to the poor thermal conductivity. An insufficient heat dissipation has a hugely negative impact on the lifetime of the LEDs.

The definitive break through was achieved with the bonding of ceramic materials with polyurethanes.The blending of these components creates a material which not only protects against moisture, has excellent heat dissipation capabilites but which also remains flexible and pliable.

This combination enabled completely new possibilities in lighting design. The way was now paved for our product series AQUALUC.

In the following pages we give you an overview of the extensive tests conducted proving the robustness of our encapsulated products.

We go ahead. Please join us.

NICOLA BARTHELME

MANAGING DIRECTOR

INNOVATIVE DEDICATION.

The excellent standard of quality which Barthelme achieves can only be generated by dedicated dialogue between lighting designer, production and user. This is why we decided to concentrate the product design and development as well as a major portion of production at our headquarters in Nuremberg, Germany.

In this way we ensure high flexibility, excellent reliability and constant quality controls. This is the hub from where our multi-lingual experts develop new customer-specific solutions for our partners and customers around the world

ENDLESS VARIETY.

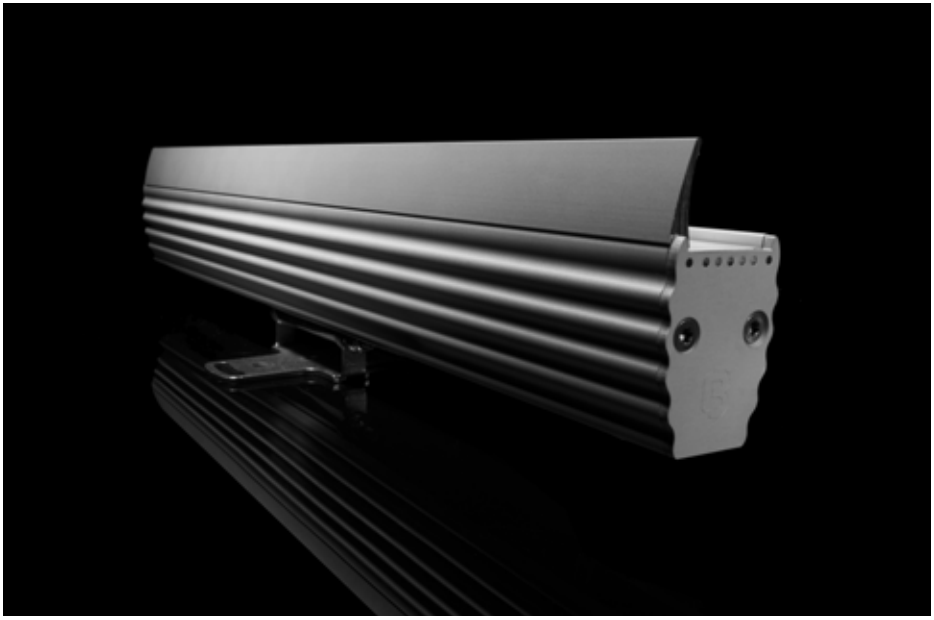
The Barthelme customised linear LED luminaires for indoor and outdoor use are manufactured according to customer specification. With our broad range of LED strips in different colour temperatures and brightness, extensive aluminium profile and cover options, numerous protection classes and connection types, Barthelme manufactures customized LED luminaires for a wide spectrum of requirements.

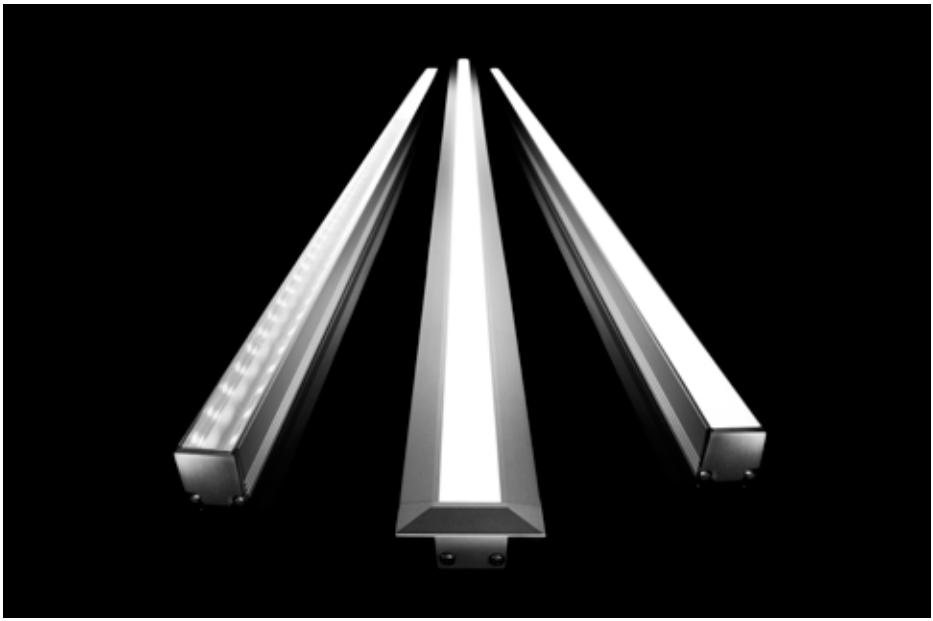
Whether as an absolutely homogenous luminaire, extremely flat with 180° or 30° optic cover; partially or fully enclosed; from 10 to 290 cm in length; equipped with simple cable outlet or PG connectors – the Barthelme individual system provides endless combinations for your lighting visions.

ELEMENTARY DURABILITY.

The AQUALUC series is extremely durable and weather-resistant and due to its high protection class IP67|68 is ideal for a broad range of outdoor and indoor applications. AQUALUC has been extensively tested for resistance to UV radiation, abrasion, salt, water, dust, and chemicals*. It is therefore perfectly suitable for shipbuilding, general outdoor lighting, pool and wellness areas as well as for garden and landscape architecture.

OVERVIEW OUTDOOR LUMINAIRES





TYPES OF COATING

The coating process in combination with the composition of the coating mixture make our components highly weather and UV resistant. The materials have been used for many years in the automobile industry in accordance with the stringent quality niveau and have successfully passed a range of diverse tests.

Barthelme offers the right coating for your luminaires designated application:

» **partly enclosed** offers protection against dew moisture and splashing water

» **clear fully enclosed (soft/hard)** for higher demands on the luminary; offers excellent lumen output with visible light spots

» **frosted fully enclosed (soft/hard)** for higher demands on the luminary; offers a homogenous and even lumination area

The fully enclosed hard coating is used if mechanical strain is exerted on the luminaire. Depending on the profile selected the luminary can be walked on.

COMPOSITION OF THE COATING MATERIAL

The distinctive characteristic of the material is its composition. The bonding of polyurethane and ceramic materials enables protection against moisture with excellent heat management and high flexibility of the plastic.

POLYURETHANE

Polyurethane (PU, DIN code: PUR) is a mixture of copolymers, nano technology and polymers and belongs to the family of plastics and synthetic resins. PU is extracted from a polyaddition reaction of polyisocyanates and polyols. It comes to a reaction of the molecules of a isocyanate group (-N=C=O) and a hydroxyl group (-OH). The result of this chemical bonding is a urethane group (-NH-CO-O-), which after hardening, poses no health risks. Depending on the manufacturing process, polyurethanes are brittle and hard or soft and flexible.

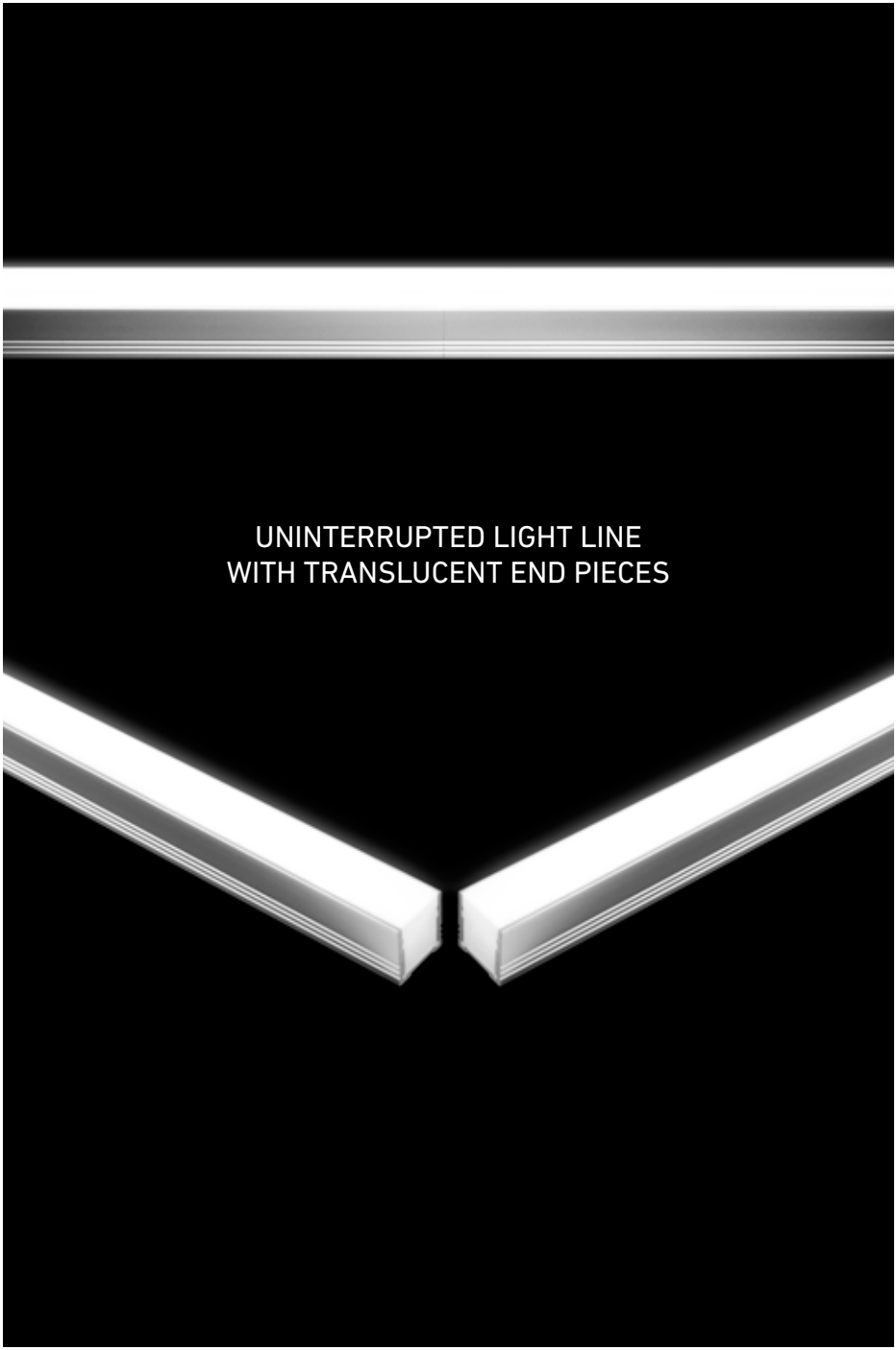

UNINTERRUPTED LIGHT LINE
WITH TRANSLUCENT END PIECES

Photo: Wind Tower, Hong Kong, Brighten Lighting Engineering Ltd.,
Photograph: Hans Astrup

Photo: Anthem of the Seas,
Project partner bluleu LED Solutions

WEATHER RESISTANCE

FLORIDA TEST
BASED ON SAE J 1976

Florida is the internationally recognised reference location for the weather resistant testing of various materials. The tests are not only realistic but are also time accelerated. The amount of UV-radiation in a year in Florida equals the UV-radiation of multiple years in numerousous reqions around the world. The alternation between highly intensive sunshine, ample precipitation and very high air humidity creates ideal conditions on the south east coast of the USA to test materials for:

» colour changes, fading and loss of gloss
» tearing, flaking, chalking and chipping
» loss of mechanical stability and physical ageing
» moisture sensitivity of products such as coatings, building substances and plastics
» biological degradation, including rot, mold, fungal and algae growth
» corrosion susceptibility

TEST CONDITIONS: direct weather influence, 45° south facing, high air humidity, very high temperature, high UV-radiation

PASSED

**NO YELLOWING,
NO LOSS OF GLOSS.**

WEATHER RESISTANCE

ARIZONA TEST
BASED ON SAE J 1976

The climate in Arizona features very intensive sunlight and high temperatures throughout the year. Compared to Florida, the location offers 20% more UV-radiation, higher annual average temperatures and lower air humidity. This desert and steppe climate is especially suitable for tests on materials which are to be permanenty used outdoors. The focus of this test is:

» loss of mechanical stability and physical ageing of plastics
» thermal expansion
» determination of the maximum operating temperature
» colour changes, fading and loss of gloss
» cracking, warping and ageing through heating

TEST CONDITIONS: direct weather influence, 45° south facing, low air humidity, extremely high temperatures, high UV-radiation

PASSED

**NO YELLOWING,
NO LOSS GLOSS.**

WEATHER RESISTANCE

XENON-WOM-TEST BASED ON SAE J 1960-89

Optical and mechanical changes can be evaluated in much less time with this simulated climatic effect test than would be possible on the basis of field tests. All necessary climate factors such as UV radiation, heat, moisture and precipitation can be simulated in this test.

TEST CONDITIONS: 65° C (149° F), 102 minutes UV-radiation and 18 minutes UV and water mist, extremely high temperatures, high UV-radiation

DURATION: 2000 hours (equivalent to 6-8 years in external use)

PASSED

NO COLOUR CHANGE, LITTLE LOSS OF GLOSS

WEATHER RESISTANCE

ACID RAIN TEST FOR PERMANENT EXTERIOR USE

The acid rain test simulates industrial air pollution with sulphur dioxide (SO2), as it is created by the burning of fossil fuels such as coal and oil products and which is the cause of acid rain. This concentrated rain is not only damaging for the environment but also damages materials which are used in the outdoors.

LEDs are extremely sensitive to sulphur as materials in the LEDs can react with the sulphur.

In the test process, the samples are exposed to an atomised solution of SO2 (600ppm) and destilled water at a temperature of 1,7°C.

The test accelerates the normal impact of SO2 on the tested material.

PASSED

**NO YELLOWING,
NO LOSS OF GLOSS.**

WEATHER RESISTANCE

UV-RADIATION TEST
QUV-A TEST | QUV-B TEST
BASED ON SAE J 2020

This laboratory test provides a perfect simulation of sunshine in the critical shortwave range of 295nm - 365nm which is mainly responsible for the damaging of polymers. All important radiation factors can be simulated in this test. The impact of sunshine and condensation on materials and stability can also be accelerated and chronicled.
In the QUV-A test our products were radiated with 340nm for over 3000 hours with a UV lamp, which equals an exterior deployment of 10 years. Furthermore, our products were radiated with 313nm for 1000 hours in the QUV-B Test which corresponds with an exterior deployment of 3-4 years.

The test intervals are indentical in the two tests and alternate between 8 hours at 70°C and 4 hours at 50°C with condensation.

The results of the QUV-A test can be clearly seen with the samples on the opposite page. The first product is an AQUALUC High Perfomance with an integrated LEDlight flex 15 HP stripe. The other stripes are from other manufacturers..

PASSED

**NO COLOUR CHANGE,
MINIMAL CHANGE IN GLOSS**

OUR PRODUCT
AFTER THE QUV-A TEST

BARTHELME LED SOLUTIONS

AQUALUC

OTHER MANUFACTURERS

WATER AND CHEMICAL STABILITY

CHLORINE TEST

If luminary systems are to be installed in pools or wellness areas then resistance to chlorine must be ensured. This test is conducted at increased temperatures of 50°C and with a chlorine concentration of 2%.

For comparison: in a normal swimming pool the maximum concentration is 0,5 - 1 mg/l which equates to a chlorine concentration of 0,001%. The test environment therefore has a 2000 times higher concentration then that which is commonly found in swimming pools.

The testing period was 60 hours.

PASSED

NO CHANGE IN APPEARANCE AND FUNCTION.

WATER AND CHEMICAL STABILITY

TEST WITH STEAM AND WARM WATER

As LEDs are increasingly integrated in steambath areas or oven lighting it is necessary to test the reaction of the material to hot steam. For this test the LED stripes were hung above boiling water in intervals of 15 to 60 cm. The duration of the test is 8 hours.

The focus of the test with warm water is the suitablity of LEDs in wellness and swimming pool areas. The encapsulated LED stripes were immersed in 45°C warm water for a duration of 240 hours. This test was conducted on the basis of WSK-M3G178.

PASSED

NO CHANGE IN APPEARANCE AND FUNCTION.

WATER AND CHEMICAL STABILITY

TEST WITH DESINFECTANTS

In this test the material resistance to desinfectant agents, as found in swimming pools, saunas or wellness centers, is evaluated.

Cleaning agents are tested which are based on the following substances:

» hydrogen peroxide (H2O2)
» sodium hypochlorite (NaClO)
» chlorine 2% (Cl)

In the testing process the material samples were exposed to a direct moist coating for a period of two hours.

PASSED

NO CHANGE IN APPEARANCE AND FUNCTION..

WATER AND CHEMICAL STABILITY

HOUSEHOLD TEST BASED ON SAE J 2020

In this test, the resistance of the products to cleaning and chemical agents, which are typically used in the household. The following cleaning agents were tested:

» Viss scouring agent
» Gut & Günstig dishwashing liquid
» Kiehl Sanpurid Citro
» Gut & Günstig vinegar-based cleanerr
» bleaching agent (Hypochlorite NaOCl 2%)
» Lysol desinfectant

In all variations of the test the material samples were exposed to a moist coating for two hours.

PASSED

NO CHANGE IN APPEARANCE AND FUNCTION.

WATER AND CHEMICAL STABILITY

IP68 PROTECTION CLASS TEST

Luminaires which are installed in pool and wellness areas are often installed under water. To determine the suitablity of the luminaires under water they were subjected to a IP68 protection class test. This test ensures full functionality - also with permanent use under water.

The test was conducted in the TÜV Rheinland laboratory in Nuremberg.
The product was tested for 5 days in a 5 meter deep water column at a pressure of 1,5 bar. No water is allowed to penetrate the housing in order to pass the test.

A SECOND TEST (BASED ON EN60529:1991+A1:2000+A2:2013) OF THE PRODUCT WAS CONDUCTED OVER A PERIOD OF 6 MONTHS AT AN IMMERSION DEPTH OF 1,2 METERS.

PASSED

NO PENETRATION OF WATER IN THE HOUSING

WATER AND CHEMICAL STABILITY

MOISTURE RESISTANCE TEST BASED ON MS-CG121

In this test the material is tested for resistance to moisture. This occurs in a climatic chamber which can simulate numerous climatic scenarios. The material samples are tested for 250 hours at an ambient temperature of 40°C and 100% relative air humidity.

PASSED

NO CHANGE IN APPEARANCE AND FUNCTION.

WATER AND CHEMICAL STABILITY

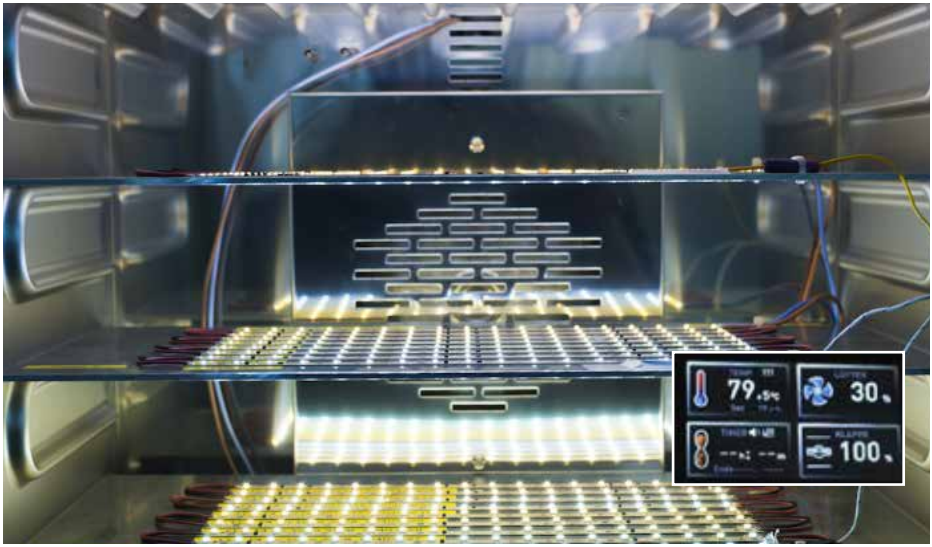
SALT SPRAY TEST BASED ON ASTM B117-95

The goal of the test is to evaluate the resistance to salt water as is found in maritime environments. The test is especially important for products which are used in saline environments such as shipyards, cruise ships, yachts, cargo ships or the navy.

The material samples were sprayed with a 5% natrium chloride (NaCl) solution for 2000 hours at a temperature of 38°C.

PASSED

NO CHANGE IN APPEARANCE AND FUNCTION.



TEMPERATURE RESISTANCE

TEST FOR THERMAL STABILITY BASED ON MS-CG121

To ensure the durability of material at high temperatures, a test was designed to simulate the ambient conditions in desert areas at temperatures of over 50°C.

The material samples were tested for 250 hours at a constant temperature of 80°C. Variations in temperature and air humidity are not tested.

PASSED

NO CHANGE IN APPEARANCE AND NO DEFORMATION.

TEMPERATURE RESISTANCE

TEMPERATURE SHOCK TEST

The temperature shock test evaluates the reaction of the material to fast temperature changes. Goal is to emulate northern climates with cold ambient temperatures and heat from thermal springs impacting on the material.

A test cycle consists of 10 runs in which the material is initially cooled for 16 hours at a temperature of -40°C. Subsequently the temperature is raised to +70°C with the addition of hot water. Concluding a run, the material is once again cooled to -40°C within 10 minutes.

PASSED

NO CHANGE IN APPEARANCE AND NO DEFORMATION

TEMPERATURE RESISTANCE

TEST FOR THERMAL STABILITY AND CYCLE CAPABILITY

This test measures thermal stability with substantial temperature changes and climatic fluctuations. Various climatic conditions can be simulated with an especially high air humidity. The evaluation of thermal stability and cycle capability is especially important for materials used in the outdoors.

The test specimens are subjected to various climatic conditions for a period of 4 hours per condition in the test process. A test cycle consists of 10 runs and includes the following climatic scenarios:

+23°C » -40°C » +23°C » + 50°C and 95% relative air humidity » +23°C » +80°C

PASSED

NO CHANGE IN APPEARANCE AND NO DEFORMATION

ABRASION AND WEAR RESISTANCE

TEST FOR ABRASION BASED ON ASTM D1044

The material is tested for walkability as found on steps and stair edges. A disc (wheel) on the test machine simulates abrasion movements with a pressure between 250 to 1000g.

The test of the material samples was conducted under medium conditions:
RAD: CS 10 | WEIGHT: 500G

A test cycle consists of 1000 runs.

PASSED

MINIMAL ABRASION

ABRASION AND WEAR RESISTANCE

TEST FOR STONE CHIP RESISTANCE BASED ON ISO 20567-1

Lighting plays an important role in the outdoors and road traffic. It is important that the luminaires are durable not only with regards to the weather but also regarding the physical stresses. In this test series the impact of stone chips on the material, as can be found in gravel, is evaluated.

In the test process, the material speciman is radiated with 500g permanent mould grains at a constant pressure of two bar at an angle of 90°. The ambient temperature fluctuates between 23°C and -25°C

A test cycle consists of ten runs.

PASSED

NO VISIBLE DAMAGE

ABRASION AND WEAR RESISTANCE

TEST WITH HIGH-PRESSURE WASHER BASED ON ISO 20567-1

A high pressure washer is often used for the cleaning of facades, walls and pathways. The material must be able to resist this stress. As a result this test was designed to evaluate the resistance of the material under these conditions.

The material samples were subjected to 50°C water temperature at a water pressure of 70 bar from a distance of 45cm. This procedure takes 30 seconds.

PASSED

NO VISIBLE DAMAGE SUCH AS WARPING, PEELING OR FLAKING OF THE MATERIAL

FLAME RESISTANCE AND ELECTRICAL PROPERTIES

TEST FOR MATERIAL FLAMMABILITY BASED ON UL94

Tests the material for flammability and self-extinguishing
TEST CONDITIONS: the test is conducted with the open flame of a Bunsen burner
TEST DURATION: 30 seconds

RESULT: SE - SELF-EXTINGUISHING – CLASSIFICATION HB (HORIZONTAL FLAME TEST)

THE TEST WAS PASSED ONLY FOR THE CERAMIC MATERIAL

FLAME RESISTANCE AND ELECTRICAL PROPERTIES

TEST FOR MATERIAL FLAMMABILITY BASED ON FMVSS 302

Tests the material for flammability, spreading of flames and self-extinguishing

TEST CONDITIONS:
- the test is conducted with the open flame of a Bunsen burner
- material strength as per application
- horizontal position of the flame

REQUIREMENT: maximum spreading of flames: 102mm/min
DURATION: 15 seconds

THIS TEST IS VALID FOR ALL MATERIALS USED AT THIS TIME

FLAME RESISTANCE AND ELECTRICAL PROPERTIES

TEST OF SPECIFIC ELECTRICAL RESISTIVITY BASED ON ASIM D257

The goal of the test is to test the material for its dielectric strength. A 2mm thick sample is subjected to a voltage of 500V DC.
DURATION: brief

RESULT: 1 X 10E15 OHM*CM

OVERVIEW OF THE REGULATORY NORMS

SYMBOL	DIRECTIVES & REGULATIONS	DESCRIPTION	ISSUED BY	SCOPE
	**REACH** Regulation No. 1907/2006-2013	Registration, evaluation, authorisation for chemical substances	Europe	SVHC list (aromatic ammines, phtalates and other carcinogenic substances)
	**RoHS II** Directive no. 2011/65/EC (Directive no. 2002/95EC)	Restriction of use of certain hazardous substances in electrical and electronic equipment	Europe	Lead, Cadmium, Hexavalent Chronium, Mercury,PBB, PBDE
	ELV Directive no. 2000/53/EC	Restriction of use of certain substances in old vehicles due to the recycling process	Europe	Heavy metals, organic substances (see GADSL 2009)
	WEEE Directive no. 2002/96/EC	Waste Electrical and Electronic Equipment	Europe	
	**UNI EN 71-3**	Safety of toys	Europe	Restriction of heavy metals
	ASTM F963	Safety of toys	USA	Restriction of heavy metals
	Directive no. 2005/84/EC	Phtalates (softener) in toys	Europe	Phtalates (softener)
	CPSIA 2008 Consumer Product Safety Improvement Act	Safety for childrens products	USA	see **ASTM F963-07**
	**EC-Directive 89/109;** 02/72;97/48;82/711;85/572;76/769 Germany §30-§ 31 LMBG Foodstuffs and Commodities Act	Materials in contact with foodstuffs	Europe	Restrictions on substances and testing of changes in flavour
	**Directive no. 2005/69/EC**	Inclusion of PAHs	Europe	PAHs (polycyclic, aromatic hydrocarbons)
	Chemical Substance Control Law 2006	Benzotriazole - Class I specified chemical substances	Japan	Benzotriazole (UV-stabilisor)
	Proposition 65	Content of chemicals causing cancer, birth defects or reproductive harm	State of California (USA)	See list 11. September 2009
	Directive No. 2006/122/ECOF	Restrictions on the marketing and use of certain dangerous substances and compounds	Europe	PFOS (perfluoroctane sulfonates)

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