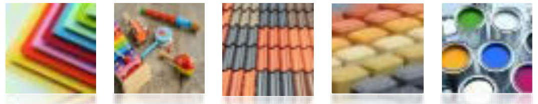
Harold Scholz & Co. GmbH

The sustainability potential of colour pigments for precast concrete solutions

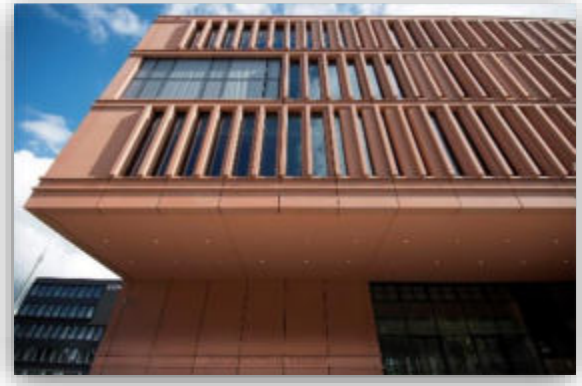
Jean-Marc Casu







Successfully Executed Projects with Bayferrox® Iron Oxide Pigments in Concrete Solutions



Justice Center– Bochum (Germany)

Museum of European And Mediterranean Civilizations - Marseille (France)

Johannes Kepler University Linz (Austria)

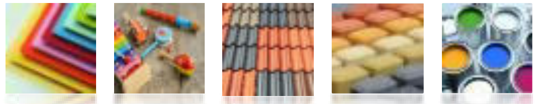
Nationalpark Center Mittersil (Austria)

Daum Space.1, Jeju Island, South Korea

Alfons-Kern-School, Pforzheim (Germany)

Coffee Plaza – Harbor City Hamburg (Germany)

Administration Building of Scholz Recklinghausen (Germany)



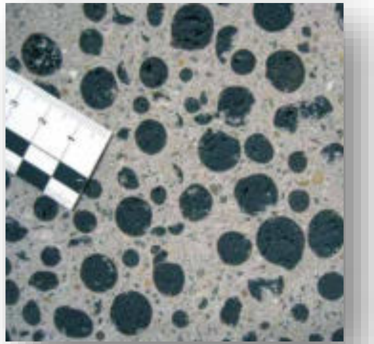
Posibilities Beside and in Combination with Pigment Application for Concrete to Shape Concrete Surfaces

Wash roughly

Wash finely

Scratching

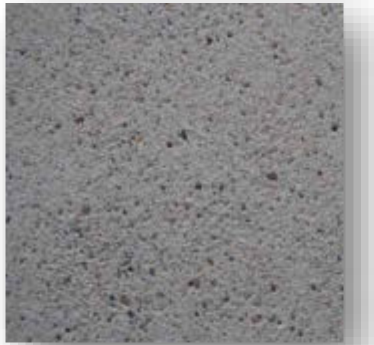
Falter



Coarse Grinding

Surface made with Matrix

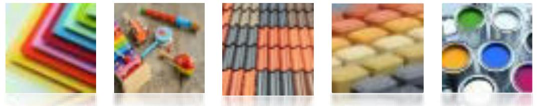
unedited



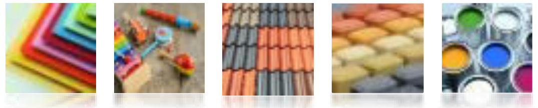
acidify

Fine grinding

Fotos: Holcim (Süddeutschland) GmbH

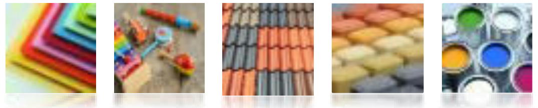


Various Supply Forms for Ideal Dosing- & Dispersing Properties in Respective Concrete Applications



Various Supply Forms for Ideal Dosing- & Dispersing Properties in Respective Concrete Applications

	Costs	Dust Disposal	Dosage	Dispersibility	Storage	Colour Variety
Powder	++	-	-	+	+	++
Slurry	-	++	+	++	-	+
Granule	-	++	++	-	+	-
Compact-Pigment	+	+	-	-	+	--



Pigment Classification & Pigment Types

Pigments

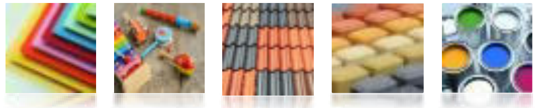
Organic Pigments

Limited use in building materials!

Inorganic Pigments

Suitable for construction materials:

- Metal oxides
- Carbon Blacks



Pigment Classification & Pigment Types

Pigments

≠

Dyes

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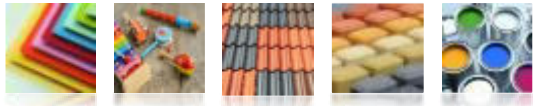


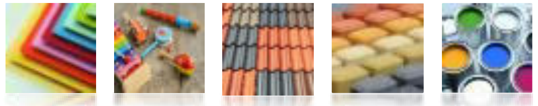
Pigment Classification & Pigment Types

Inorganic Pigments for Colouring Concrete:

Iron Oxides	Fe_3O_4	black	brown shades (mixtures)
	Fe_2O_3	red	
	FeOOH	yellow	
	γ-Fe_2O_3	brown	
Carbon Black	C	black – (shows problems when fixed in the cement stone matrix)	
Titanium Dioxide	TiO_2	white	
Chrome Oxide	Cr_2O_3	green	
Cobalt spinel	$CoAl_2O_4$	blue	

Mixed phase pigments of colour shades yellow, orange, green, black

Only metal oxide pigments should be used to color concrete



Harold Scholz & Co. GmbH – Sustainable Production of Iron Oxide Pigments at our partner LANXESS in Germany

A broad technology portfolio covers the full spectrum of iron oxide solutions

LANXESS
Energizing Chemistry

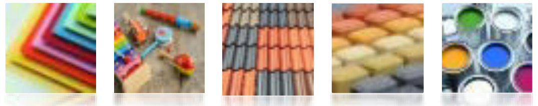
Synthesis | **Advanced refinement and milling processes**

Synthesis:
- Laux process
- Precipitation process
- Penniman process
- Ningbo process

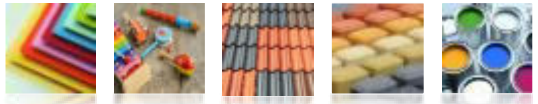
Advanced refinement and milling processes:
- Thickening and washing
- Pigment coating (for selected product types only)
- Drying and/or calcination
- Color adjustment and milling
- Packaging

Integrated synthesis and blending sites

Sustainable Pigment Production of our partner LANXESS in Germany since 1926



Pigments with Individual Life Cycle Analysis & Environmental Product Declarations (EPD)



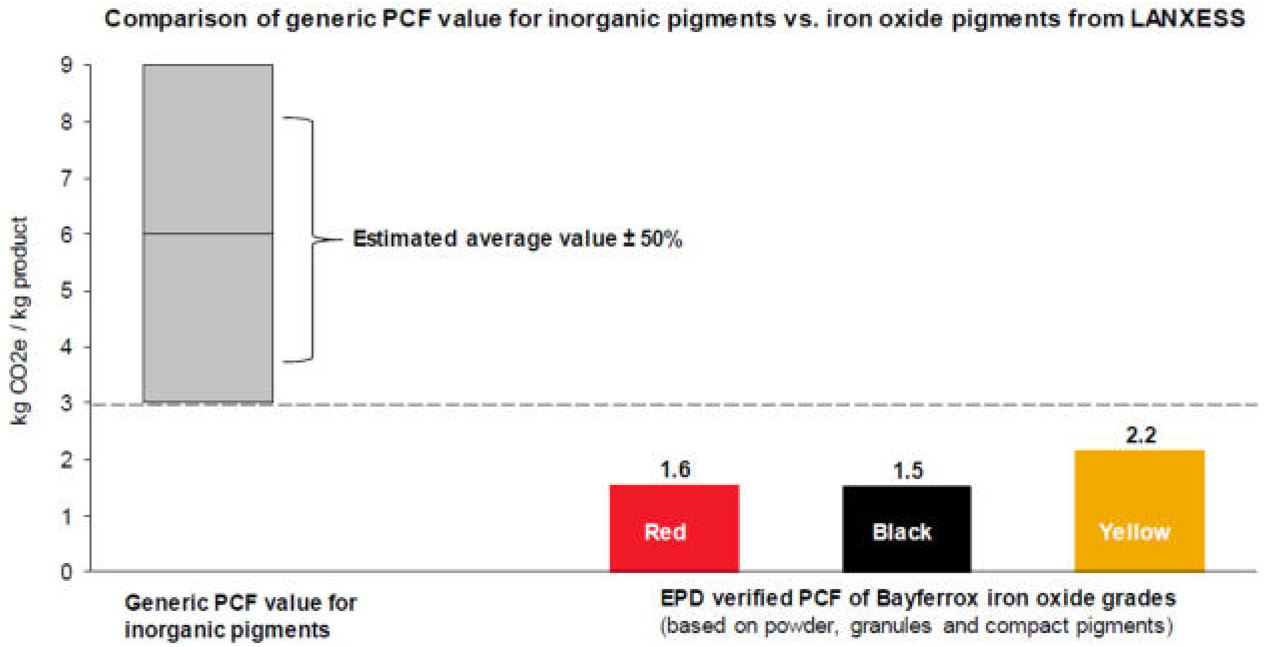
Pigments with Individual Life Cycle Analysis & Environmental Product Declarations (EPD)

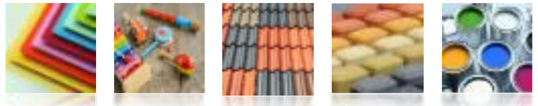
LANXESS EPDs provide verified data for coatings producers to make their value chain more sustainable

LANXESS
Energizing Chemistry

- With its EPDs LANXESS is making the environmental impact of it sproducts transparent
- Benchmarking with other market alternatives is ensured, e.g. regarding the CO2 footprint
- If no values are available inaccurate, generic values must be used

The CO_2 footprint of iron oxides can vary significantly depending on the manufacturer and its manufacturing process





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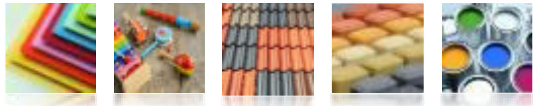

Comparison of Emissions & Ressource Demand – Black Pigment vs. Concrete

5. LCA: Results

The following tables show the environment-relevant results as per EN 15804 for 1,000 kg iron oxide black pigment (weighted average for the compacted, powder, granulate and micronized versions).

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	MND	MND	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1000 kg Iron oxide black pigment

Parameter	Unit	A1-A3	A1	A2	A3
Global Warming Potential total (GWP-total)	kg CO_2 eq	1.77E+03	9.97E+02	1.37E+02	6.4E+02
Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq	1.69E+03	9.9E+02	1.37E+02	5.61E+02
Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq	8.51E+01	6.32E+00	-4.83E-01	7.93E+01
Global Warming Potential luluc (GWP-luluc)	kg CO_2 eq	9.61E-01	4.15E-01	5.16E-01	3.02E-02
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	4.29E-06	4.29E-06	1.05E-10	6.54E-10
Acidification potential of land and water (AP)	mol H⁺ eq	3.04E+00	2.18E+00	3.58E-01	4.97E-01
Eutrophication potential aquatic freshwater (EP-freshwater)	kg P eq	3.26E-02	3.22E-02	2.82E-04	1.13E-04
Eutrophication potential aquatic marine (EP-marine)	kg N eq	9.85E-01	6.32E-01	1.62E-01	1.9E-01
Eutrophication potential terrestrial (EP-terrestrial)	mol N eq	1.07E+01	6.73E+00	1.82E+00	2.11E+00
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg NMVOC eq	2.64E+00	1.78E+00	3.29E-01	5.26E-01
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb eq	1.14E-03	1.09E-03	1.5E-05	3.07E-05
Abiotic depletion potential for fossil resources (ADPF)	MJ	3.07E+04	2.07E+04	1.82E+03	8.16E+03
Water use (WDP)	m^3 world eq deprived	4.28E+01	2.13E+01	6.54E-01	2.08E+01

Tabelle 1: Auszug aus der EPD Beton C45/55 – Ergebnisse der Ökobilanz für 1 m³ Beton [13]

Umweltauswirkungen	Einheit	A1-A3	A4	A5	B1[2]	C1-C3	D
Globales Erwärmungspotenzial (GWP)	kg CO_2-Äq.	286,0[1]	29,10	1,08	-10,0	21,11	-21,40
Abbau Potential der stratosphärischen Ozonschicht (ODP)	kg CFC11-Äq.	7,72E-8	5,75E-12	4,71E-12	0	1,61E-11	-1,32E-10
Versauerungspotenzial von Boden und Wasser (AP)	kg SO_2-Äq.	0,406	0,072	1,60E-3	0	0,073	-0,047
Eutrophierungspotenzial (EP)	kg $(PO_4)^{3-}$-Äq.	0,081	0,017	2,57E-4	0	1,64E-2	-8,86E-3
Bildungspotential für troposphärisches Ozon (POCP)	kg Ethen Äq.	0,035	-0,024	1,11E-4	0	-6,95E-3	-2,79E-3
Potenzial für den abiotischen Abbau nicht fossiler Ressourcen (ADP_{el})	kg Sb Äq.	1,02E-3	3,11E-6	5,36E-7	0	3,57E-6	-8,60E-6
Potenzial für den abiotischen Abbau fossiler Brennstoffe (ADP_{foss})	MJ	1.360,0	394,1	10,5	0	273,1	-227,00
Ressourceneinsatz	**Einheit**	**A1-A3**	**A4**	**A5**	**B1**	**C1-C3**	**D**
Total erneuerbare Primärenergie (PE_{ern})	MJ	282,0	26,5	5,89	0	34,5	-94,10
Total nicht erneuerbare Primärenergie (PE_{nern})	MJ	1.500,0	395,8	13,66	0	282,6	-279,0
Einsatz von Sekundärstoffen	kg	11,0	0	0	0	0	2.400,0
Erneuerbare Sekundärbrennstoffe	MJ	264,0	0	0	0	0	0
Nicht erneuerbare Sekundärbrennstoffe	MJ	502,0	0	0	0	0	0
Einsatz von Süßwasserressourcen	m³	0,88	0,01	0	0	0	-1,28

[1] Hierin nicht enthalten sind 42 kg CO_2-Äq. aus der Verbrennung von Abfällen bei der Herstellung von Zementklinker. Weitere Erläuterungen siehe EPD-Text.
[2] Durch Carbonatisierung nehmen Betonbauteile während ihrer Nutzungsdauer Kohlendioxid auf. Weitere Erläuterungen siehe EPD-Text.

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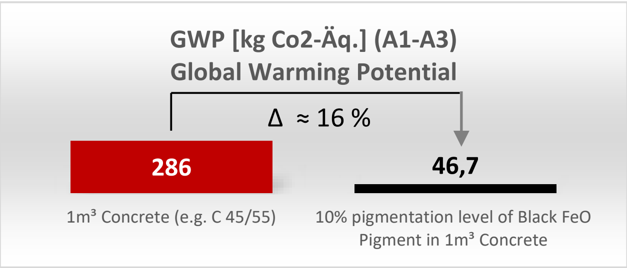
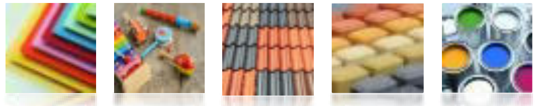
Source: FDB-Merkblatt No 10 – Fachvereinigung Deutscher Betonfertigteilbau e.V.



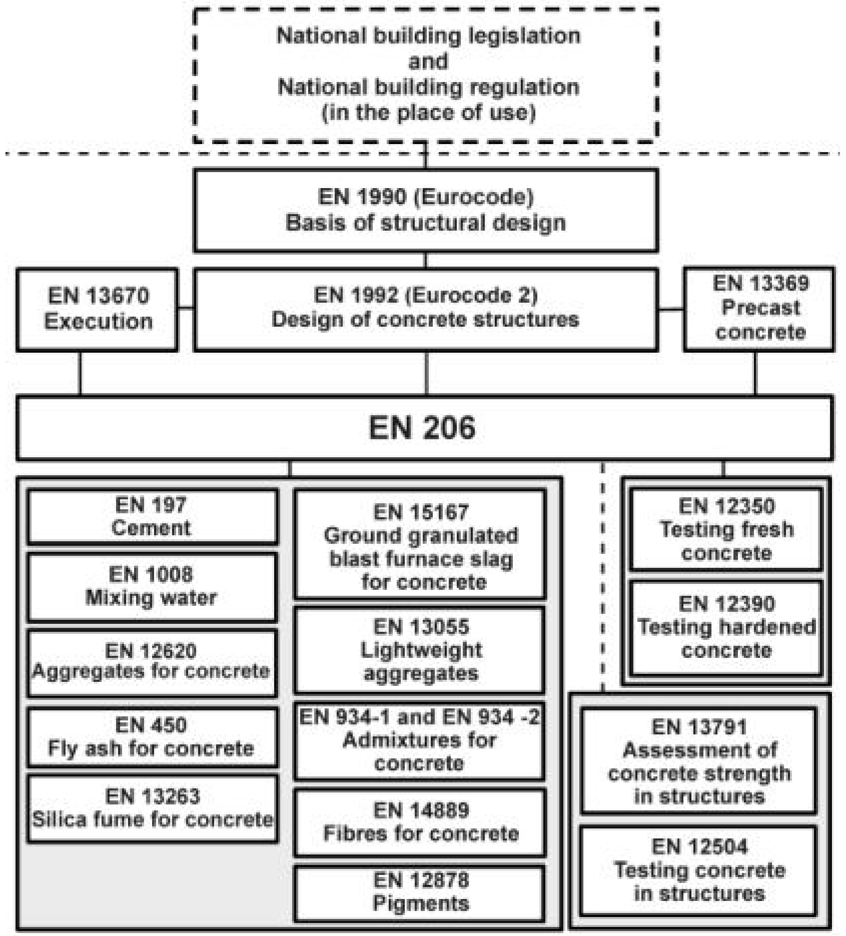
In 1m³ Concrete pigments can have a CO_2-Impact of approx. 16% (worst case)



Pigments in Compliance with EN 12878 Standard

The Application of concrete requires the compliance of various standards for different components of concrete in terms of:

- Planning of the construction object
- Adequate usage of raw materials
- Adequate Production of concrete
- Correct Material Testing
- Professional execution of construction work



Source: EN 206 – Relationships between EN 206 and standards for design and execution, standards for constituents and test standards

Pigments in Compliance with EN 12878 Standard

DIN EN 12878:

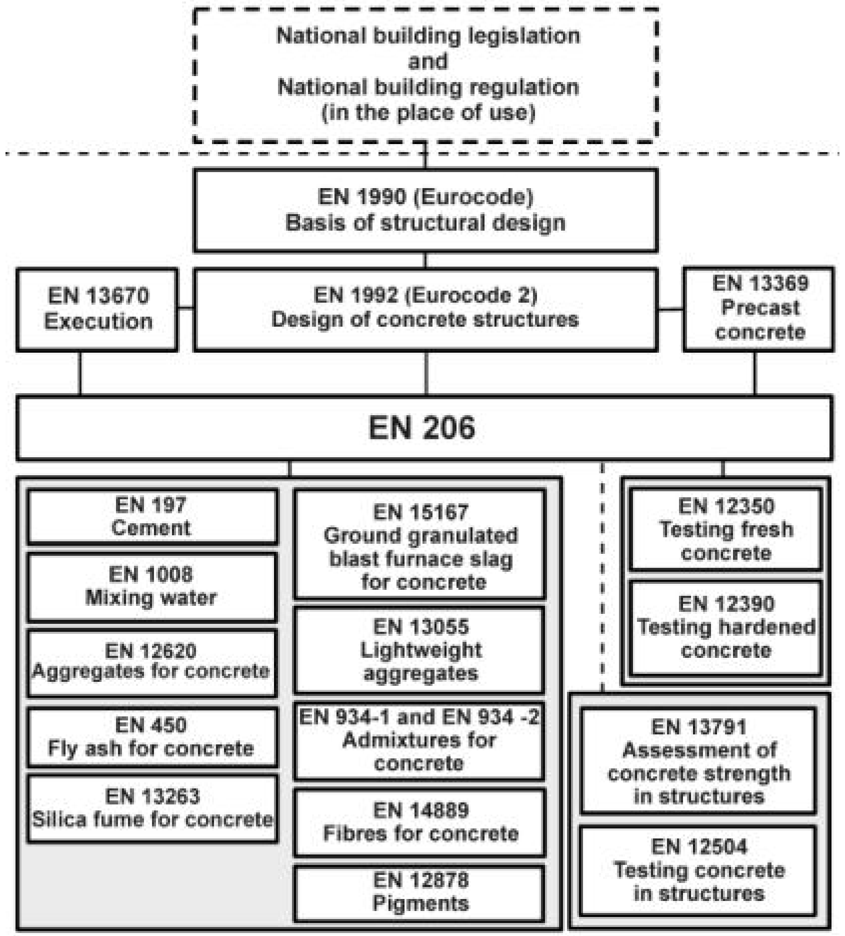
Controls the requirements and testing procedures of pigments for colouring cement- and calcitic building materials

in terms of:

- Alkaline resistance, cement fastness
- Weather resistance
- Heat resistance
- Constant colour strength
- Constant colour shade
- Limited influence on concrete technological properties (consistancy, solidification & hardening)

Important: DIN EN 12878 differentiates between:

- **Category A:** pigments for concrete without steel reinforcement
- **Category B:** pigments for concrete with steel reinforcement (higher requirements)



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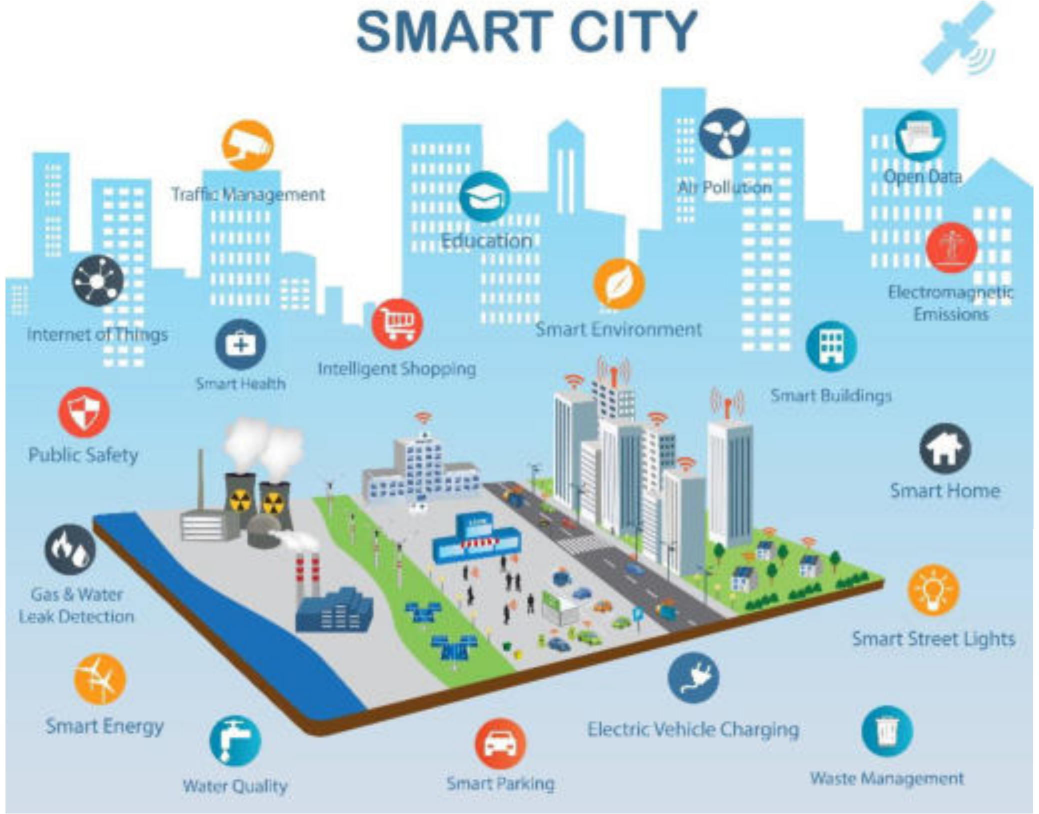
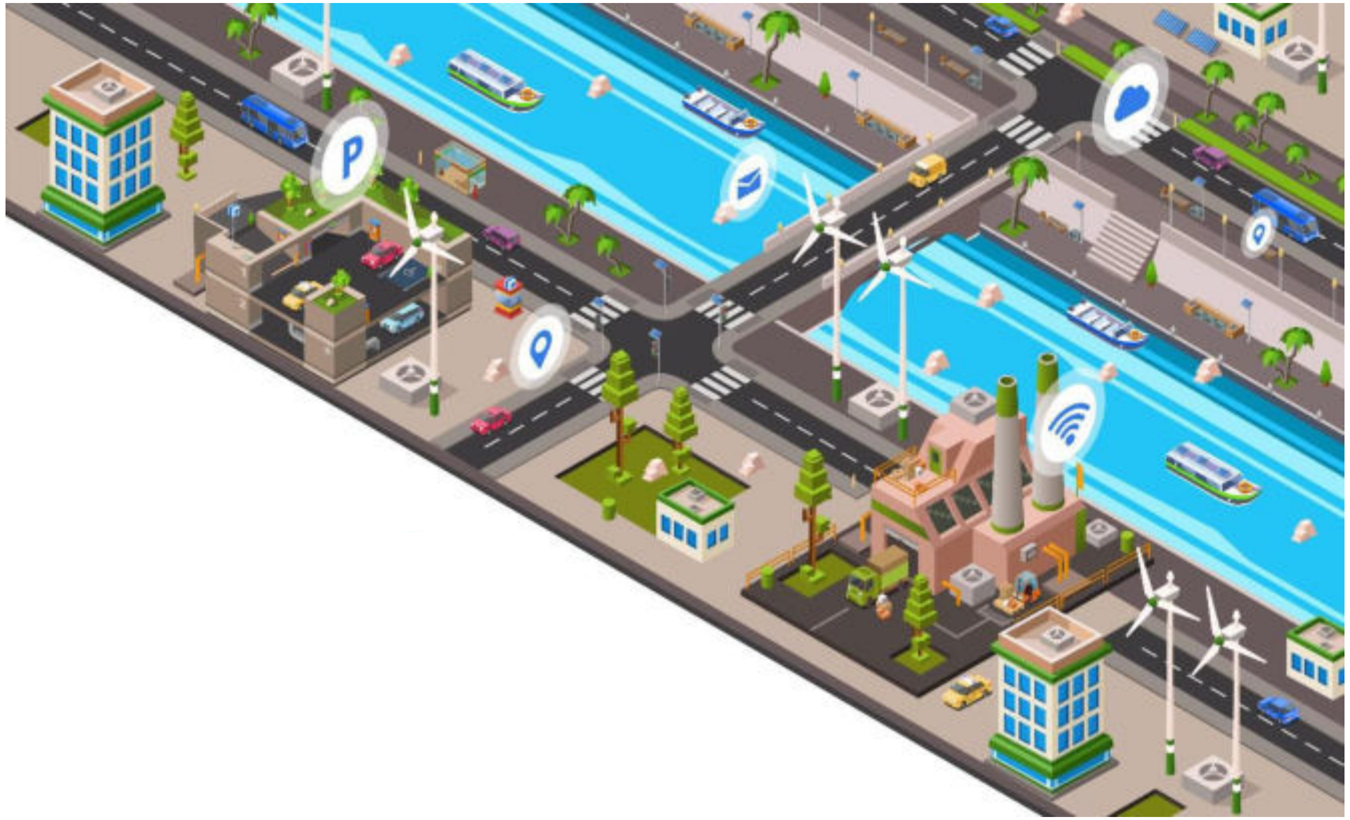
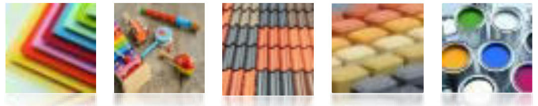
Vision of the Future – Possible Mega Trends with Pigment Involvement







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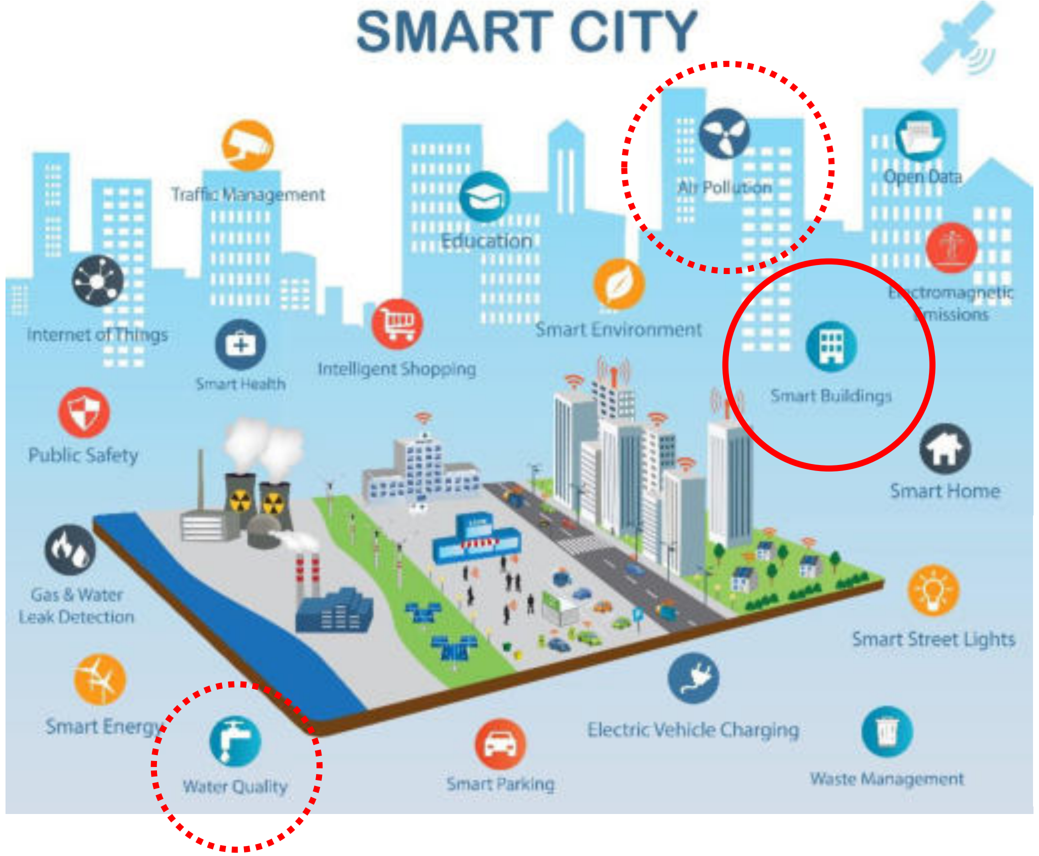
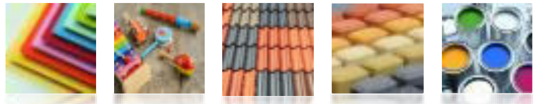


Sectors with contribution potential of pigments:

- Air Pollution (TiO_2)
- Smart Buildings (Carbon Black)
- Water Quality (Iron Oxide)

The Role of Carbon Black Pigments for Smart Buildings



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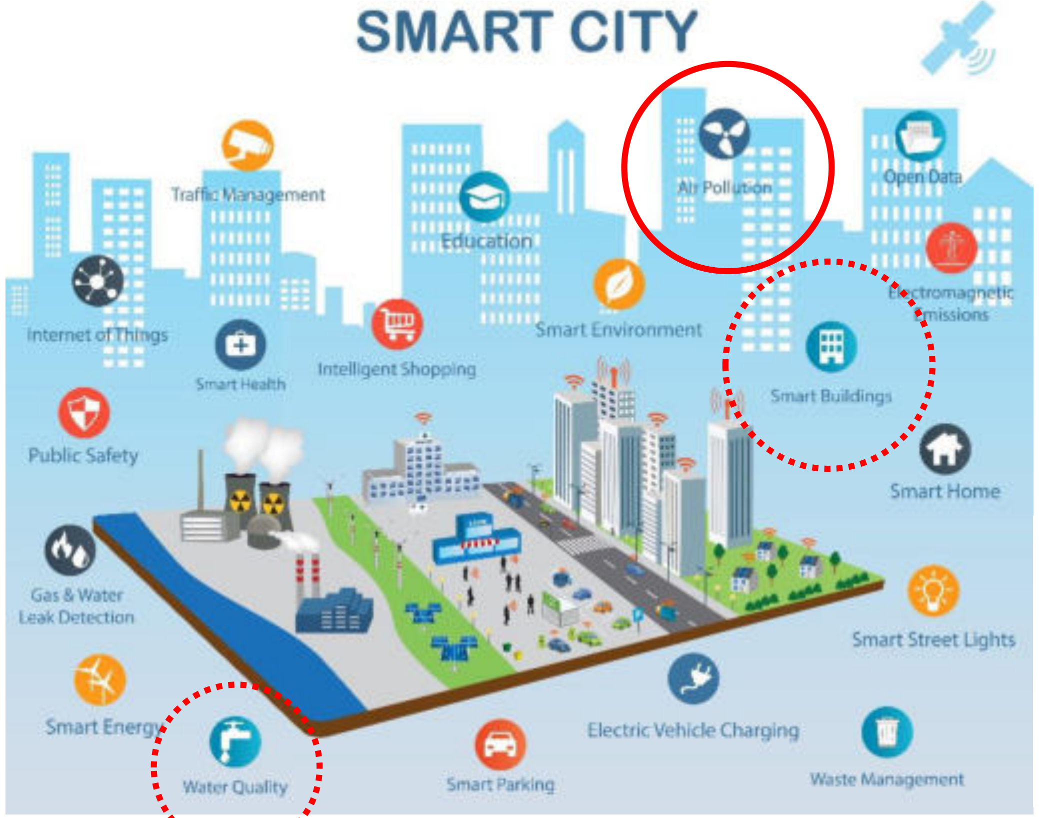

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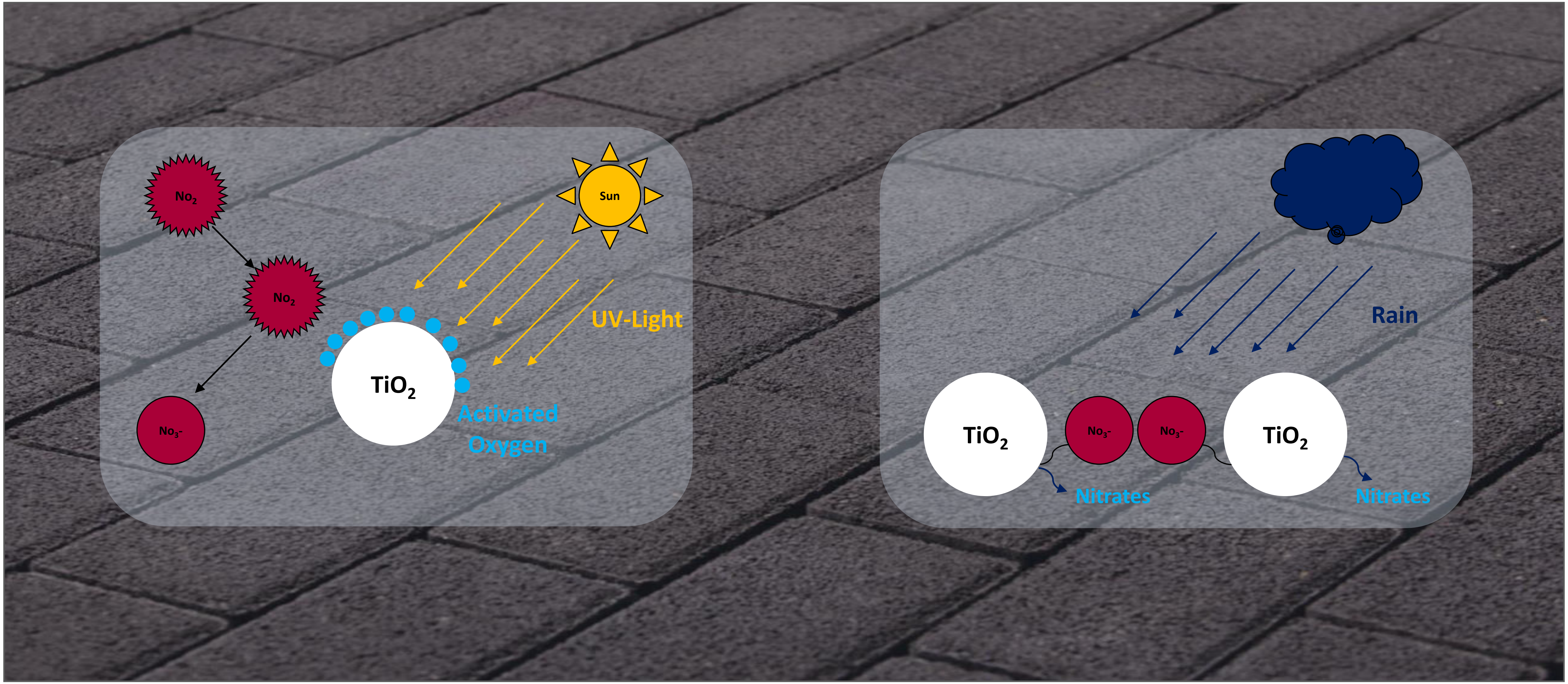
Photocatalytic Process based on Titanium Dioxide



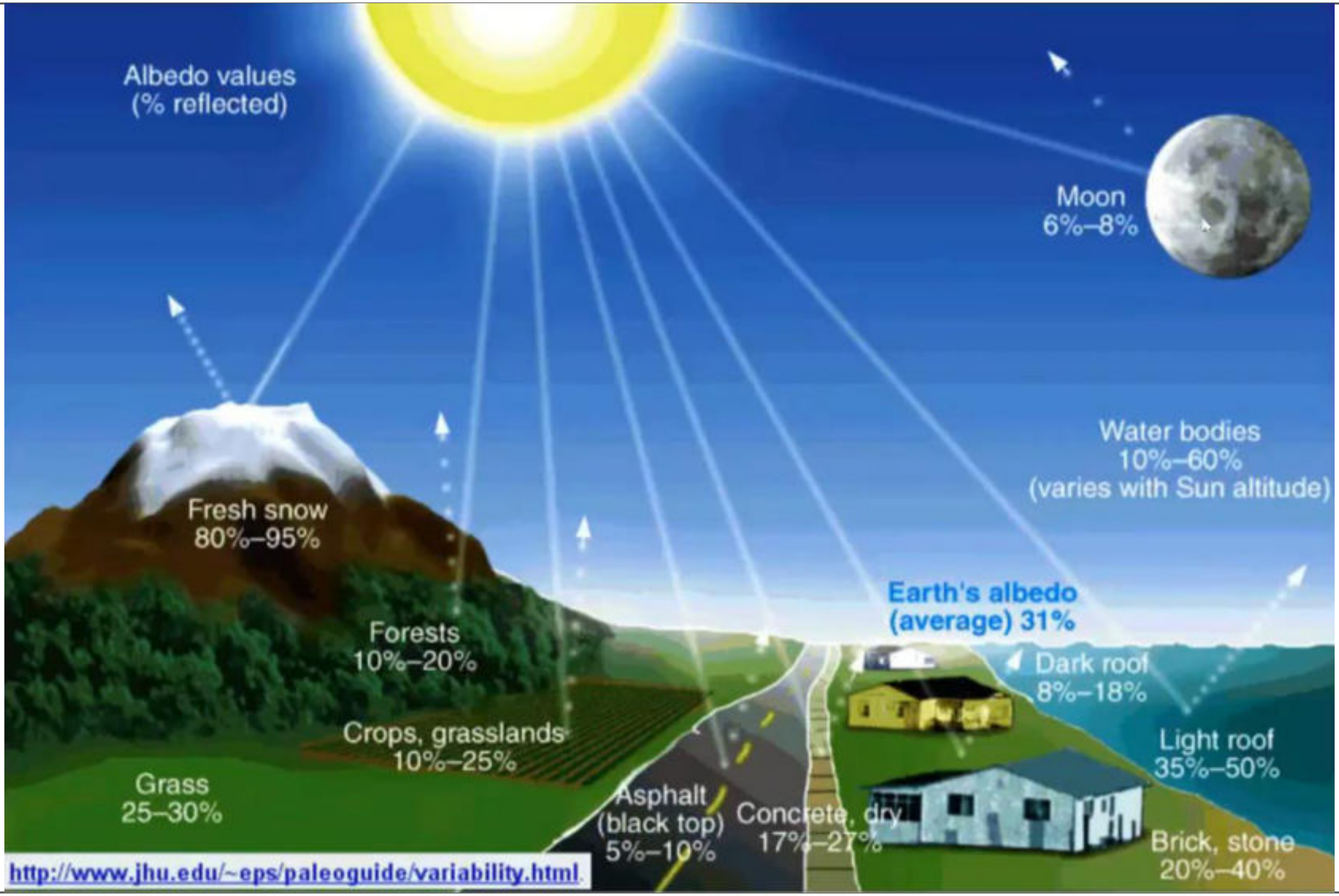
The Role of Titanium Dioxide to the Urban Heat Island Effect

The Role of Titanium Dioxide to the Urban Heat Island Effect

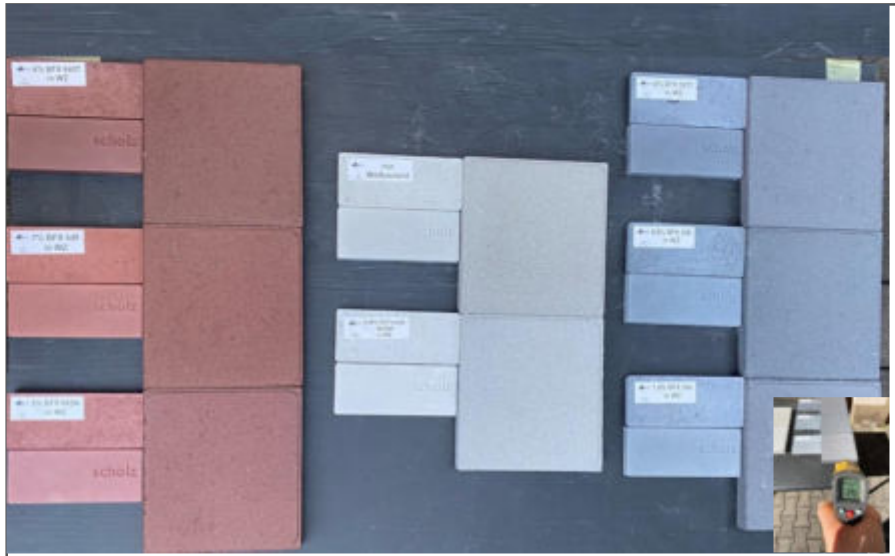
Negative effects on humans, animals and our planet:

- Higher air pollution levels
- Heat-related illnesses and discomfort of people
- Higher demand for air conditioning and energy resources

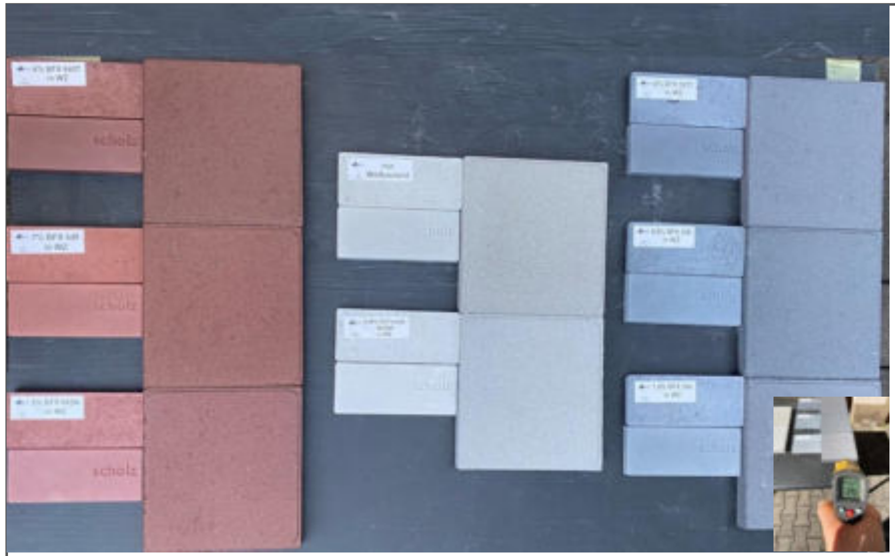
The Role of Titanium Dioxide to the Urban Heat Island Effect

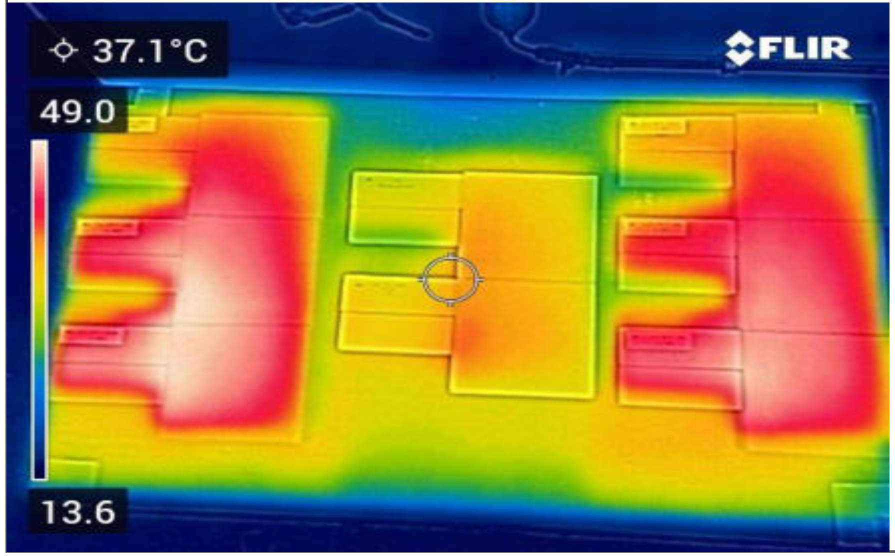


Investigation on Light Reflection Behaviour and Surface Heating of Pavers and SCC w & w/o TiO_2

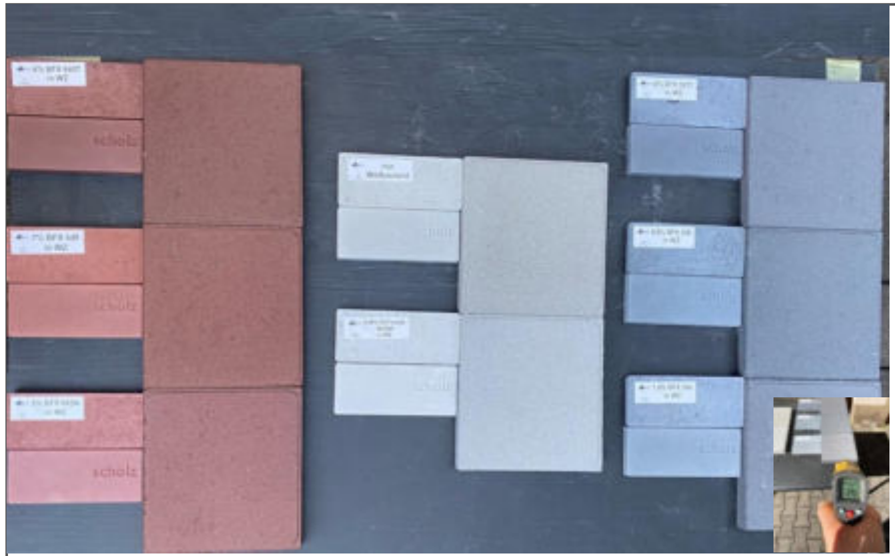


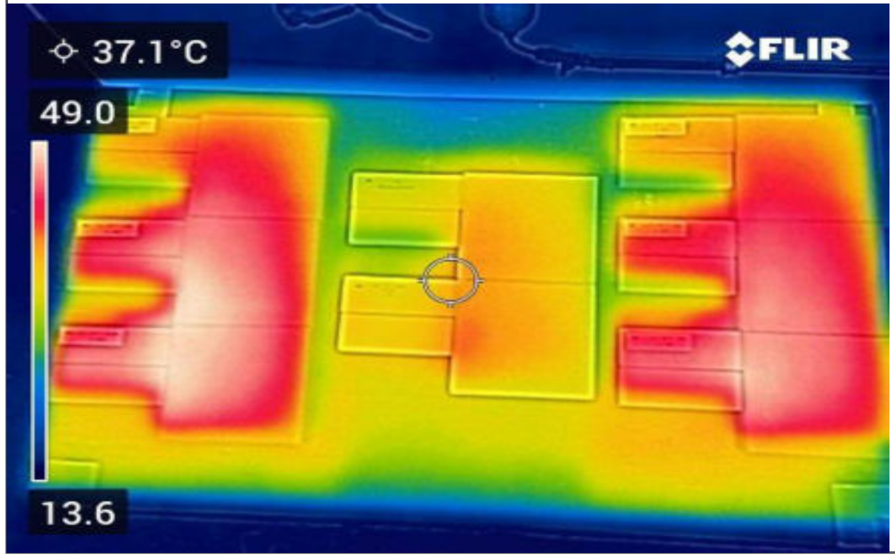
Investigation on Light Reflection Behaviour and Surface Heating of Pavers and SCC w & w/o TiO_2





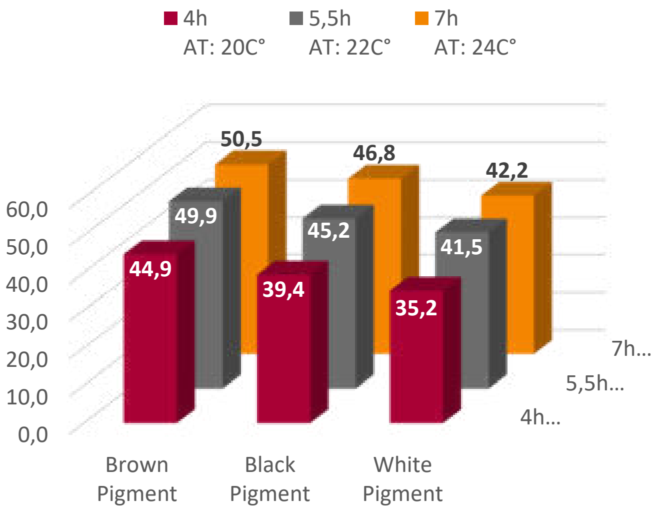
Investigation on Light Reflection Behaviour and Surface Heating of Pavers and SCC w & w/o TiO_2



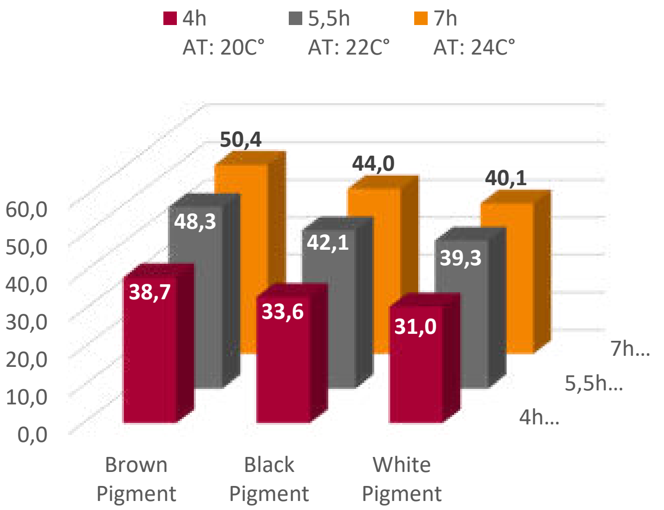


Pigment	Duration/Exposure to Sun Self Compacting Concrete			Duration/Exposure to Sun Paving Stones		
	4h AT: 20C°	5,5h AT: 22C°	7h AT: 24C°	4h AT: 20C°	5,5h AT: 22C°	7h AT: 24C°
Brown Pigment	44,9	49,9	50,5	38,7	48,3	50,4
Black Pigment	39,4	45,2	46,8	33,6	42,1	44,0
White Pigment	35,2	41,5	42,2	31,0	39,3	40,1

Self Compacting Concrete



Paving Stones

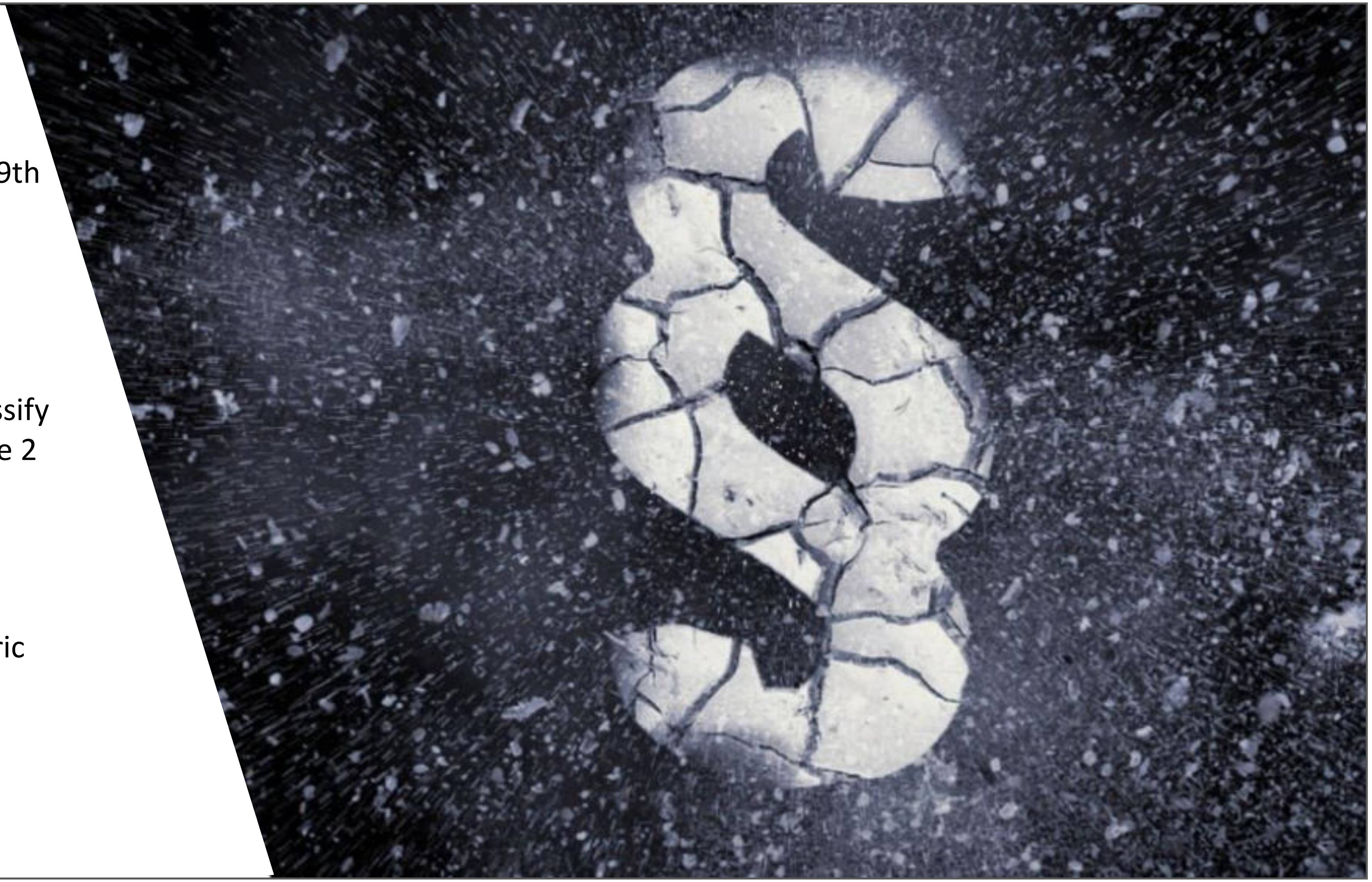


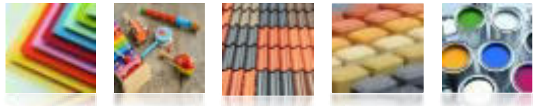
Titanium Dioxide – Regulations & Solutions

- Classification of titanium dioxide as substance with suspected carcinogenic effects when inhaled, came into force on 9th March 2020

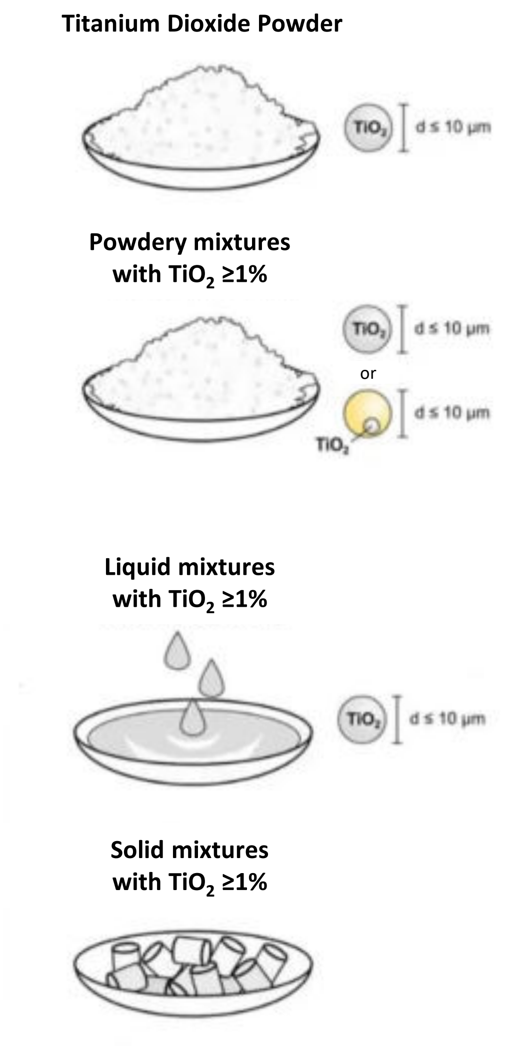
- The classification of the EU refers to the Enhaling of titanium dioxide dust with a content of min. 1% with an aerodynamic particle size of <10 µm and intends to classify TiO_2 as carcinogenic on a level of categorie 2

- Since 9th September 2021 on, the requirements to Labeling of powder products, liquid or solid mixtures with a respective solid content became obligatoric

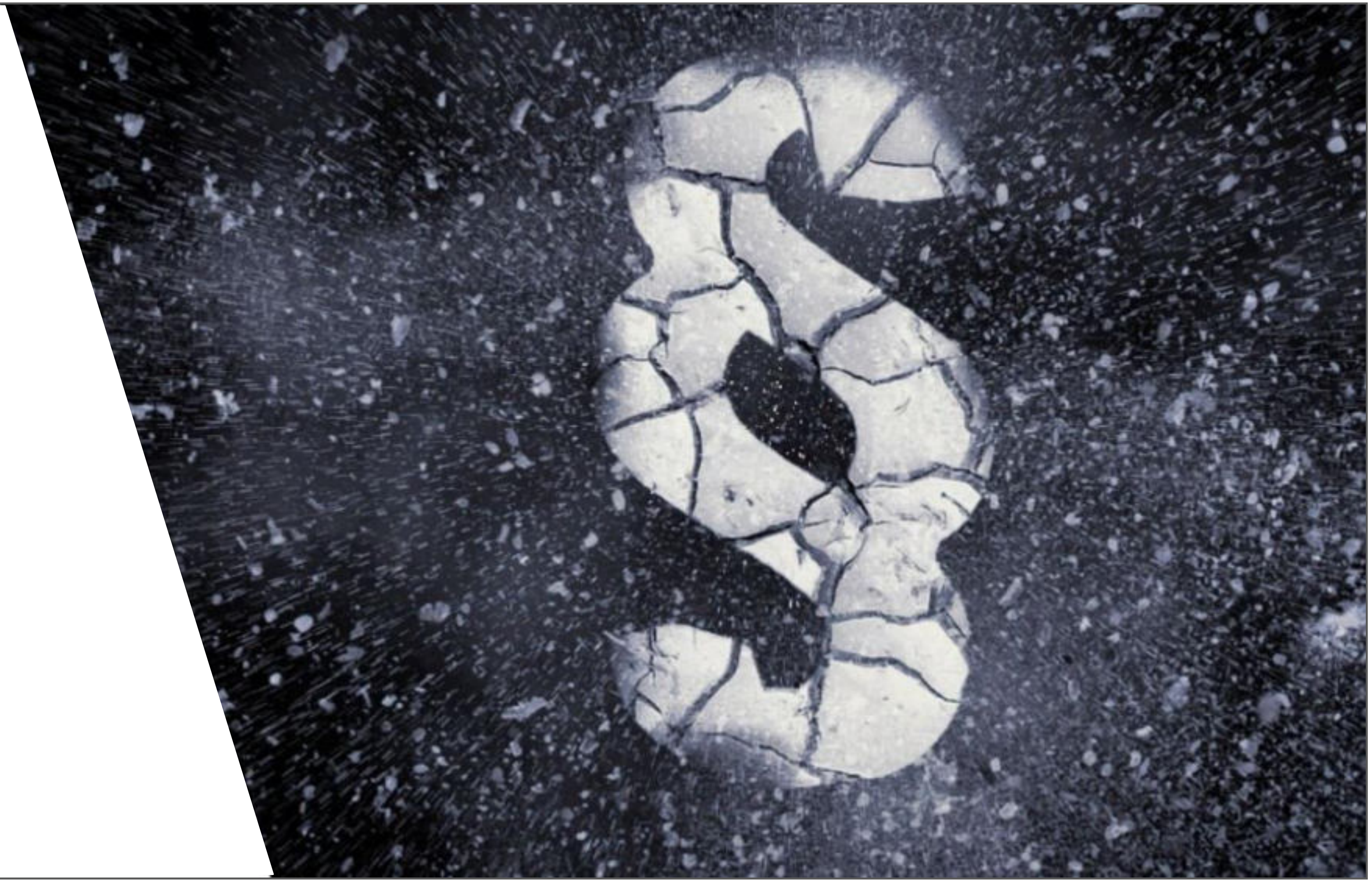




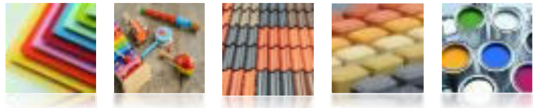
Titanium Dioxide – Regulations & Solutions



Source: VDMI



Titanium Dioxide – Alternatives



Titanium Dioxide – Regulations & Solutions

- DUST-FREE PIGMENT PREPARATION
- NO DANGER TO RESPIRATORY ORGANS
- NO AGGLOMERATIONS
- BEST DISPERSIBILITY PROPERTIES
- SHORTEST MIXING TIMES POSSIBLE

Thank You For Your Attention!

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