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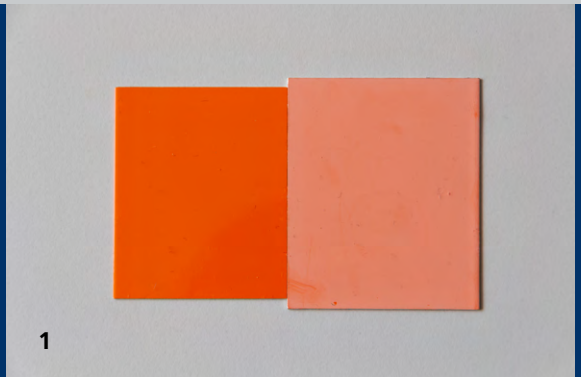

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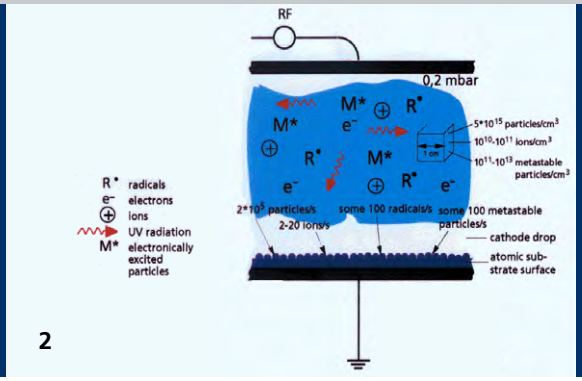

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1 *Paint surface before and after plasma weathering.*

2 *Particles in a plasma. The particle streams shown always refer to 1 nm² of the surface.*

PLASMA WEATHERING OF SURFACES

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB
Nobelstrasse 12
70569 Stuttgart
Germany

Contact

Dr. Jakob Barz
Phone +49 711 970-4114
jakob.barz@igb.fraunhofer.de

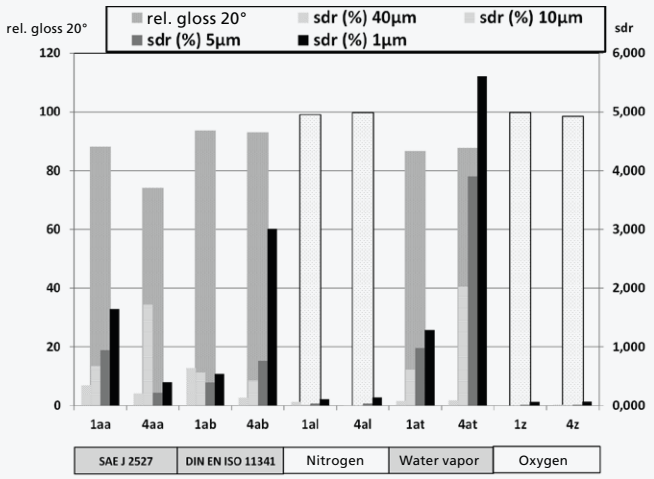
www.igb.fraunhofer.de

State-of-the-art: Time-consuming outdoor weathering for new materials

Before new paints or polymeric material surfaces are used for outdoor applications, they must be tested for weather resistance at outdoor weathering locations. These tests may take several months or even years; the alternative is several thousand hours in weathering chambers with beam sources. Regardless of whether the test is carried out in certified outdoor weathering stands from third-party suppliers or with own weathering equipment – the test cycles are tedious and cost-intensive due to the need for electricity and beam sources.

Alternative: Plasma weathering shortens development times

In order to develop and market product innovations more quickly, Fraunhofer IGB develops together with industrial partners new testing methods that permit developers to analyze the degradation characteristics of polymer surfaces, within a very short time and with a low consumption of energy. These evaluations should be comparable to those obtained with the conventional certified methods.



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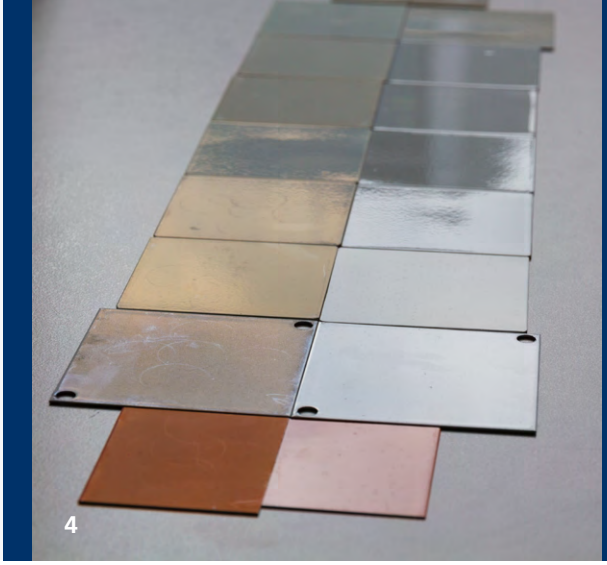

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Imitation of natural weathering using plasma processes

The plasma serves as a source of radiation and particles. By igniting a plasma, atoms and molecules are stimulated in the gas phase and partially ionized; existing molecules are fragmented and thus chemically activated. Many particles are stimulated in the plasma and relax under light emission, resulting in a broad electromagnetic spectrum. Radical chemical as well as photochemical reactions take place in the plasma phase and on the surface of the samples exposed to the plasma. If required, plasma ions can also be used to erode the surface. The composition of the plasmas can be controlled via the process parameters (pressure, plasma power, gas flow and gas type, duration of treatment). Fig. 2 shows the numerical ratios of the particles generated in a low-pressure plasma.

Verification of the degradation characteristics just hours later

In studies carried out by Fraunhofer IGB, polyurethane paint samples were weathered in various plasma atmospheres. Fig. 3 shows the results obtained using water vapor plasmas, compared with two standard weathering processes. Weathering with the addition of gaseous water produces degradation to the surface after only 60 minutes, whereas with classical artificial weathering according to SAE J 2527 degradation characteristics become evident only after more than 1000 hours. This shows that artificial and plasma weathering result in a comparable degradation pattern, here reflected in the measurements for surface roughness and gloss.

Advantages

Through the effects of radiation, chemically reactive particles and temperature, many typical material changes can be achieved in a single process step with plasma weathering processes. Thus, the duration of weathering can be reduced by orders of magnitude, thus shortening material development cycles and significantly reducing energy consumption.

Suitable materials

- Polymers
- Paints and varnishes
- Other organic materials

Range of services

- Test weathering at IGB
- Development of a customer-specific weathering process

3 *Comparison of various plasma and standard weathering processes for polyurethane paint. The bars show the results from the standard testing methods according to SAE J 2527 and DIN EN ISO 11341 as well as with a water vapor plasma. The measurements shown are the relative gloss and the surface roughness (sdr).*

4 *Plasma weathered paint surfaces compared to untreated surfaces.*