

Presse release of the company IST METZ GmbH

April 2011

UV Varnishing for Complex Geometries

As part of a funded research project carried out by Deutsche Bundesstiftung Umwelt (one of Europe's largest foundations promoting innovative environmental projects - DBU), Lankwitzer Lackfabrik GmbH and the UV system manufacturer IST METZ GmbH tested the coating and curing of three-dimensional objects with solvent-free UV varnish systems

The most modern of UV varnishes today can be cured within seconds using UV lamps. This innovative and commercially interesting method requires the development of a varnish system that meets the special requirements of customers and facilitates the complete, consistent curing of the entire object. The through-curing of a UV varnish is first achieved when the necessary intensity and amount of UV light has reached all varnished surfaces of the object.



Image 1: The task of illuminating an entire object with UV light is all the more difficult with objects of complex geometry, in particular with three-dimensional objects. A diesel injection pump, for example, has a highly complex surface structure.

To date, more than 90% of varnishes used for coating 3D parts have been solvent-based, thermally cured varnishes. The aim of the work carried out by IST METZ and Lankwitzer was to find a way to substitute these varnishes with UV varnish.

Virtually emission-free UV-curing ink and varnish systems are already successfully used in offset-, flexo-, screen and inkjet printing, as well as for cast-, spray- and vacuum coating. Geometrically simple, two-dimensional objects (e.g. paper, cardboard, steel, etc.) are used here. UV-curing coatings are also an option for industrial applications, such as in the automotive industry, for example to protect against the corrosion of diesel injection pumps, brake discs, brake drums, clutch

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linings, etc. This involves, to a small extent, the coating of difficult three-dimensional parts. However, the use of UV curing technology on simple geometries (preferably even surfaces) is generally standard. The aim is always to achieve a short and equal distance between the substrate and the UV lamps. This is exactly what makes the coating of geometrically complex 3D objects with environmentally friendly, solvent-free UV-curing varnishes in a three-dimensional space such a major challenge.

Coating three-dimensional objects with UV-curing varnishes is primarily hindered by the fact that the object surfaces are subjected to a varied amount and intensity of UV light as a result of their uneven distance and exposure to the lamp. This means that object surfaces located a short distance and parallel to the UV lamp are through-cured in a matter of seconds, while those surfaces further away or perpendicular to the light require considerably longer. And this is exactly what the planned research project from Lankwitzer and IST METZ set out to address.

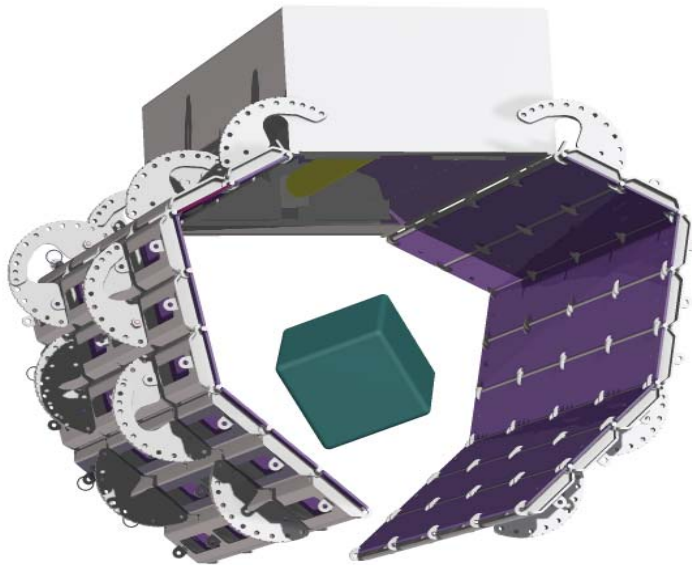


Image 2: Using a faceted reflector adjustable in 5% steps, the MBS-3D UV system can even cure varnish layers on complex 3D objects

Tests have shown that by reducing the O₂ (oxygen) content in the curing area, the energy required for the UV curing of the varnish can be drastically reduced. Alternatively, the distance between the UV lamps and the surface to be cured can be increased. This opens up additional options for both curing technology and the formulation of varnish. Reducing the residual oxygen to 2% thus makes it possible to reduce the amount of photoinitiators by 80% without any effect on, or sometimes even an improvement to, the quality of the varnish and process properties.

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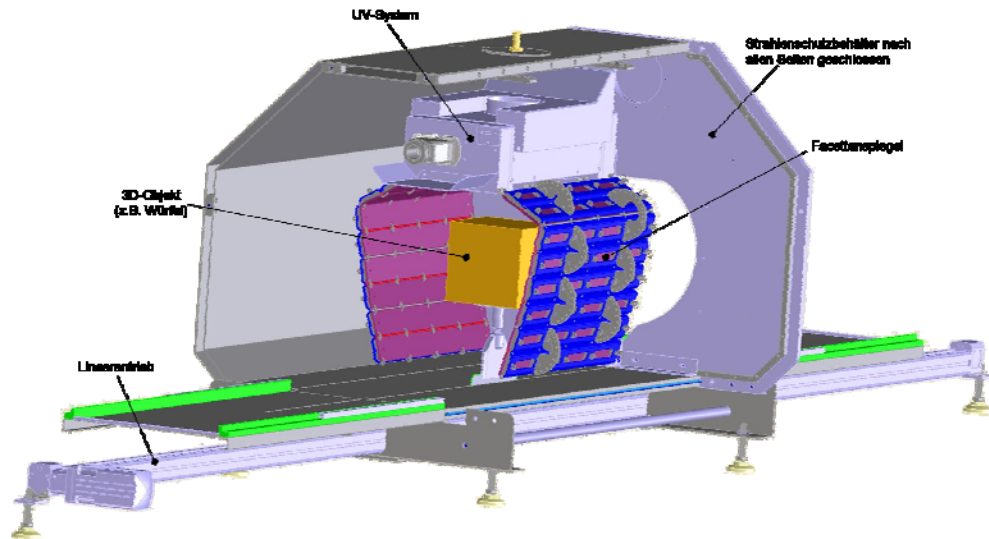


Image 3: The object to be irradiated is subjected to nitrogen in an inert chamber (“UV tunnel”) in order to reduce the residual oxygen to 2%

It was found that the varnish was less prone to discolouration, the processing speed could be increased and the number of UV lamps reduced. By changing the varnish formula, the penetration depth of the UV light can also be increased, leading to superb curing results on all surface levels and thus a better adhesion of the coating to the substrate. In order to achieve this reduction of the oxygen content, the process environment was subjected to N₂ (nitrogen); the researchers then examined and developed the resulting effects. The aim was to increase the distance between the UV lamps and the surfaces to be cured from 10 cm to 50 cm, without any deterioration in the quality of the coating. The plan to coat 3D objects in this way also involved eliminating the use of drying ovens and cooling zones for the drying of solvent-based varnishes and thus reducing energy consumption by up to 50%.

A cube was used as a test object during the development phase. The surface of the cube was covered with magnets so that simple Q-panel sheet metal could be placed on all sides, which was later subjected to laboratory testing.

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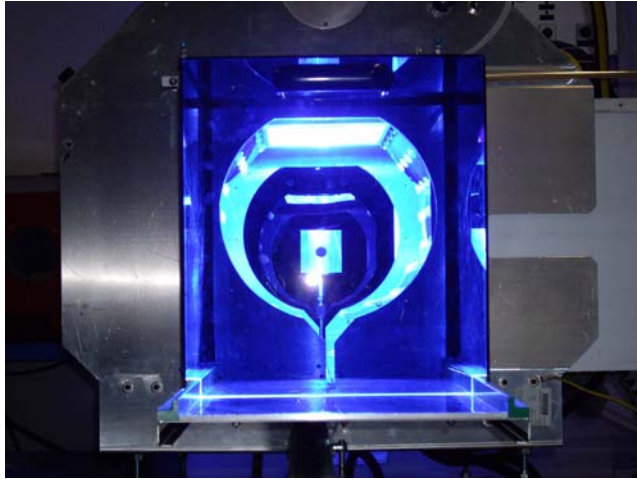


Image 4: The image shows the view into the UV tunnel while the test object is travelling on the linear drive

During the project, the newly developed varnish systems and the solutions for the highly efficient UV irradiation of 3D objects (edge length 100 - 500mm) were tested on practical examples under inert (reduced oxygen) conditions and the results documented. For example, one 3D reference object used was a pump. Using computer-supported raytracing simulation, the optimum position of the UV system reflectors can be calculated. First, a 3D model of the object is created and loaded into the simulation software. The surface of the pump is taken as the receiver of the UV radiation and the simulation provides information on the radiation intensity for the entire surface. The limit values given by the varnish system can thus be considered virtually and the necessary homogeneity in the radiation ensured. It was a similar process for the "aluminium rim" reference object. Due to both the size (edge length ~ 500 mm) and complexity of the part, there was initially a 180° rotation required for the necessary UV intensity and radiation homogeneity. An 18" rim was selected as a reference object for this scaling task.

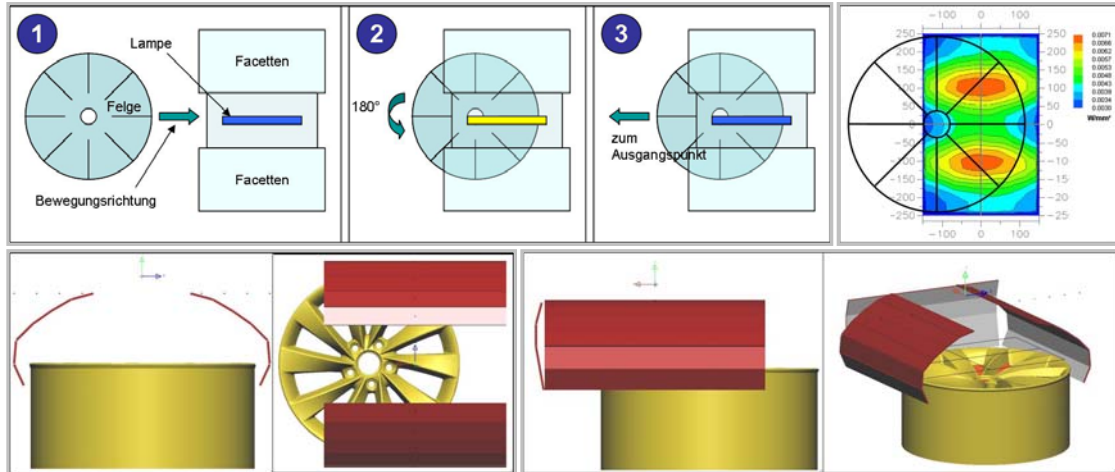


Image 5: Top: The image shows the movement of the rim in the UV tunnel. Below: The rim and the correspondingly formed reflectors which form the UV tunnel can be seen.

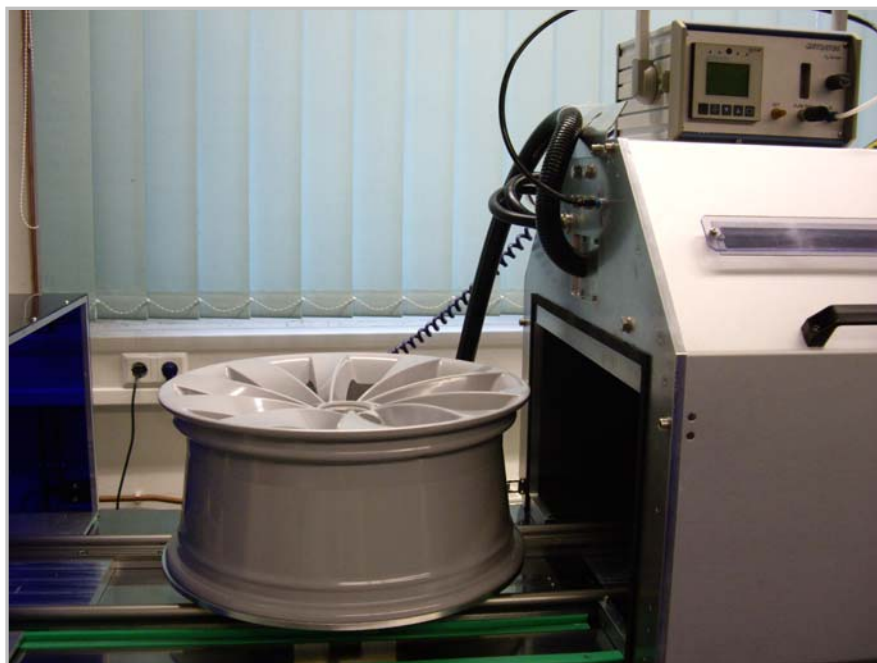


Image 6: The rim is in the starting position. It will then be turned towards the right in the inert chamber and positioned under the MBS-3D. After turning 180°, the rim is reversed out of the tunnel and can be removed.

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The simulation provides a complete overview of the radiation situation. The actual 3D surface is taken into consideration, as is the movement of the rim selected during radiation. Even objects with a complex 3D geometry can be extremely homogenous and irradiated with just one UV system.

In order to maximise the efficiency of a UV system, it is not only the geometry of the reflectors that is important but also the optical properties of the surface. A new type of coating has been developed for this, one which offers maximum reflection (> 97%) for the UV area, with simultaneous reflection of the VIS and IR spectral ranges useful for many 3D applications.

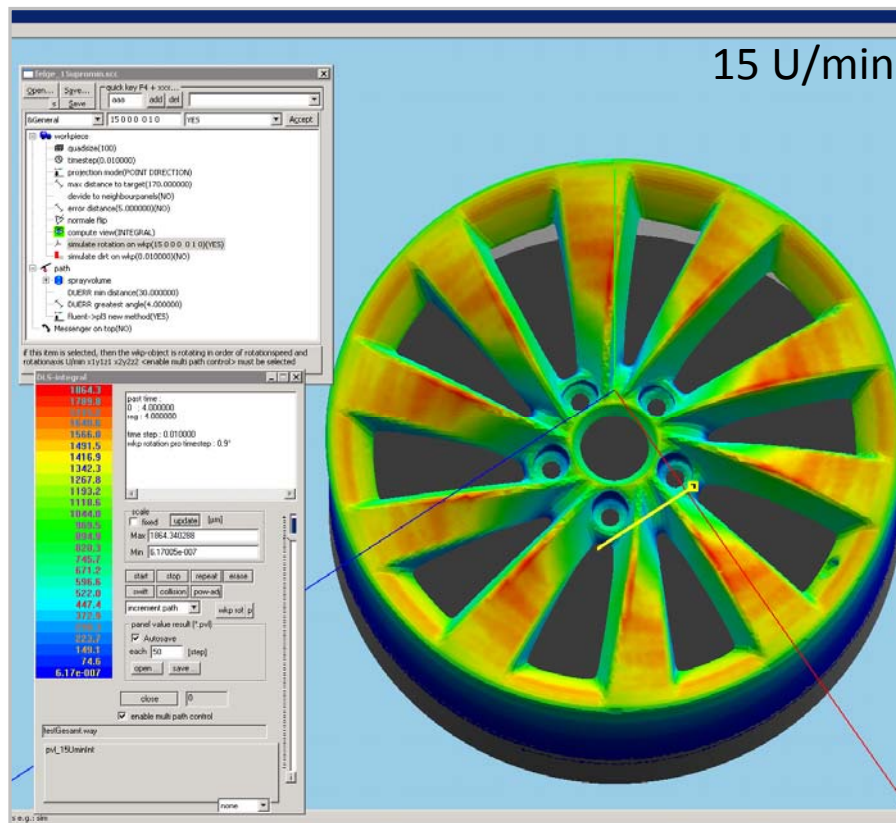


Image 7: The graphic displays the homogenous radiation result after the movement of the rim in the UV tunnel

The UV system jointly developed by Lankwitzer and IST METZ has many uses, whether it be the curing of varnish layers on tubes and casings or the many technical parts in the automotive industry.



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Your contact:

IST METZ GmbH
Lauterstrasse 14-18
72622 Nuertingen
Telefon (0 70 22) 6 00 2 – 0
Telefax (0 70 22) 60 02 53
e-mail: info@ist-uv.com
<http://www.ist-uv.com>