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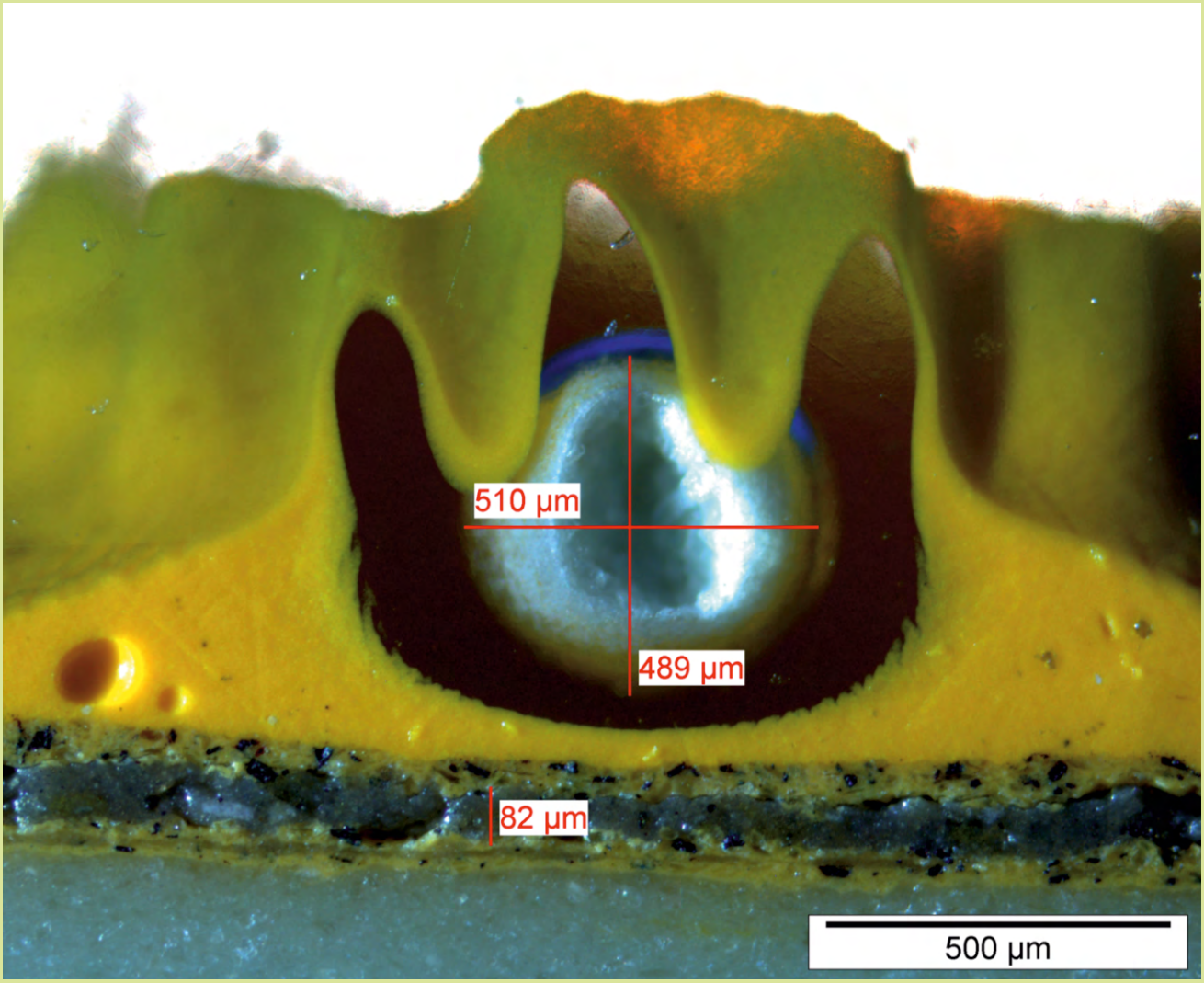
FRAUNHOFER INSTITUTE FOR MANUFACTURING ENGINEERING AND AUTOMATION IPA

FAILURE ANALYSIS ON COATINGS



IDENTIFYING AND PREVENTING COATING DEFECTS – WE CAN HELP!

Identify the cause

The reasons for defects on decorative and functional coatings can be highly diverse, for example deficiencies in the curing process, incorrect mixing ratio of a two-component coating system, contamination by substances impairing wetting, the inclusion of foreign particles or defects in the substrate. In some cases, at least two unintentional changes of the system can occur simultaneously. On their own, these would not cause any damage, but in combination they can be responsible for major failures. Since the reason for the defect in each case is unique, a tailored approach to troubleshooting is required.

Take corrective action

Despite high quality standards in paint shops and carefully monitoring raw materials, coating defects are nevertheless observed again and again. This leads to high reject rates, sometimes resulting in compensation payments and a loss of customer trust. In such cases, fast and effective remedial action needs to be taken. Our team will gladly assist you, drawing on a wealth of expertise in chemical and physical analysis as well as in painting processes. In personal discussions with our customers, we work together to identify failure patterns and develop individual solutions to rectify the problem.

Ensure quality

Once a problem has been identified and remedial action taken, appropriate quality control measures must be implemented to avoid similar errors in the future.

OUR APPROACH

Personal discussion with presentation of the overall process and assessment of defects (visual appearance, failure rate, etc.)

Non-Disclosure Agreement (if desired)

Individual offer with a choice of suitable analysis methods, if necessary with on-site process analysis and sampling anywhere in the world

Conclusion of contract

Fast processing, constant transfer of results

Corrective measures recommended

Process support during implementation of corrective action

Production support through subsequent quality control

EXAMPLES OF FAILURE ANALYSIS

Delamination of a UV coating

Defect
The UV-cured coating can be simply removed from the substrate with a tape without any further force being required.

Analysis
No substances impairing wetting were detected on the substrate. However, infrared spectroscopic analysis of the double bond conversion shows that the coating was not cured right down to the interface with the substrate.

Solution
Some UV lamps were replaced, although the replacement lamps were not ideally suited to the UV coating. Suitable radiation sources must be used for the curing process to avoid adhesion failures.

Imprint marks on varnish

Defect
The varnish is much softer than usual and tends to show imprint marks on applying light pressure.

Analysis
Infrared spectroscopic analysis revealed that the mixing ratio of the varnish and hardener of the 2-component coating was not within specifications.

Solution
The 2-component mixing process was set incorrectly and required adjustment. Analytical checks during the process ensure the right mixing ratio.

Delamination of zinc powder paint

Defect
Large quantities of zinc powder paint flake off from a piece of manufacturing equipment and impair the production process.

Analysis
Thermogravimetric analysis revealed that the zinc powder paint tends to significantly degrade the binder at certain temperatures. Therefore, this zinc powder paint is unsuitable for the manufacturing equipment when used in the stated temperature range.

Solution
Due to the thermal and chemical stress experienced by the manufacturing equipment, a more stable paint system is recommended.

Partial delamination of coating from the metal substrate

Defect
The coating appears to delaminate at random from solid metal parts.

Analysis
The coating has highly irregular layer thicknesses. Analysis by gas chromatography coupled with mass spectrometry revealed significant amounts of residual solvent in areas where the layer was thicker. In addition, the glass transition temperature measured by differential scanning calorimetry is too low for this application and evidence of postcuring processes was detected.

Solution
The coating must be applied with the specified layer thickness and cured at an optimum temperature.

ANALYTICS AND MATERIALS TESTING

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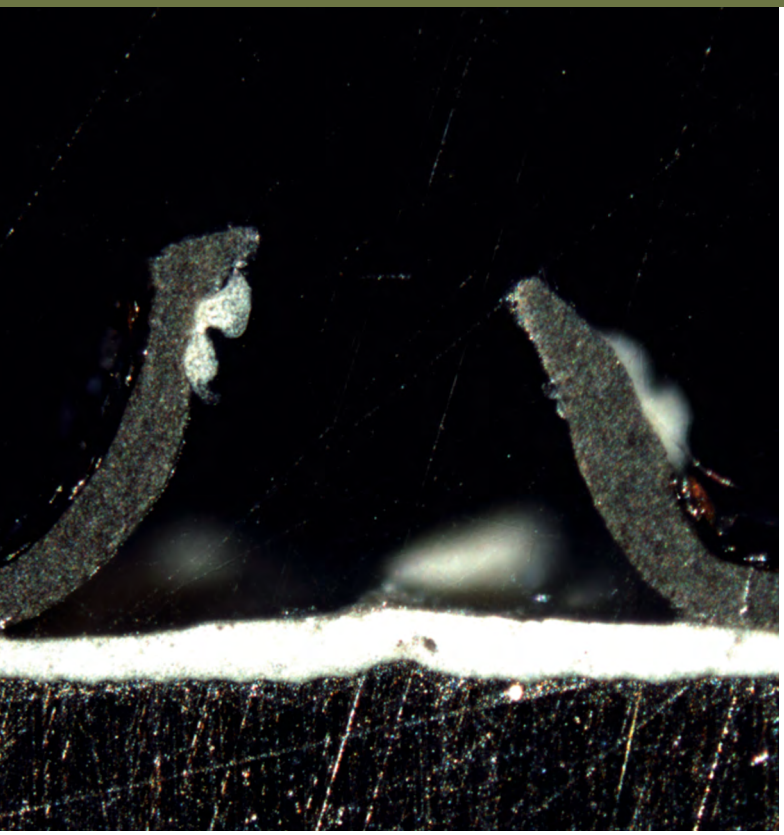

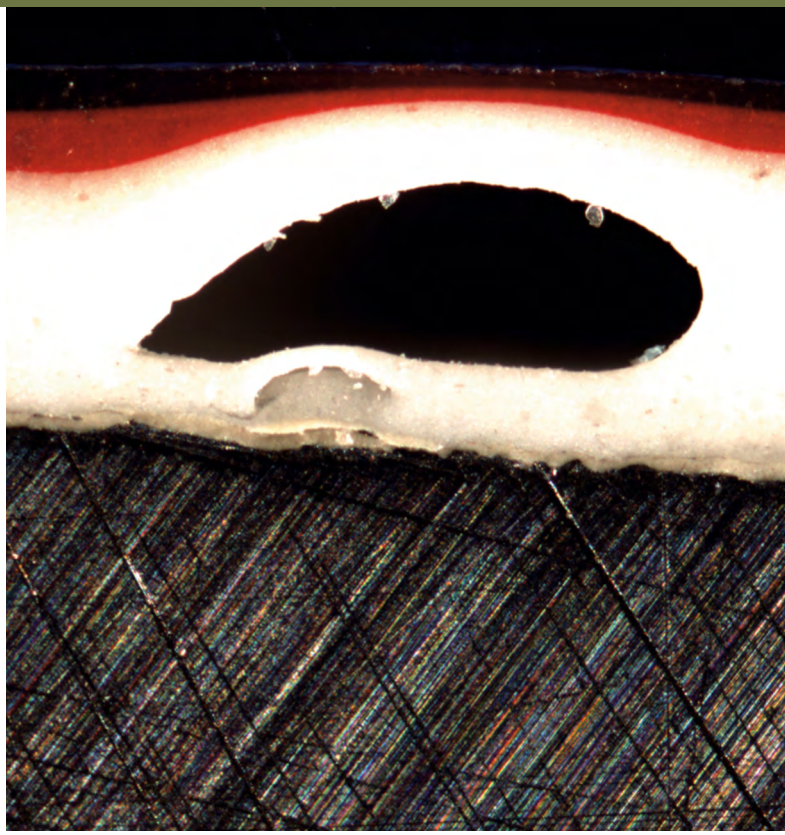

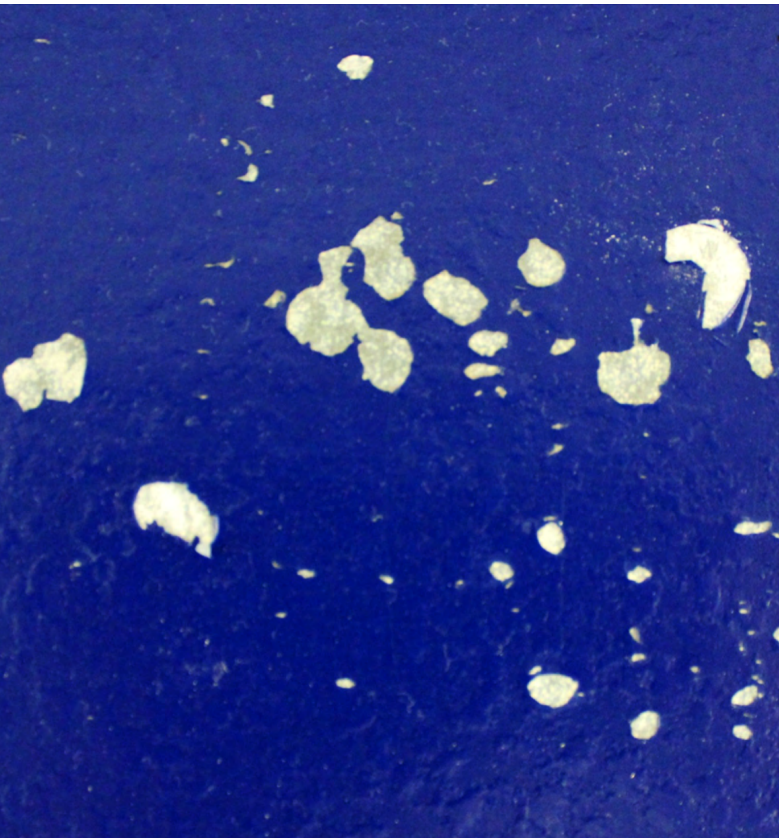

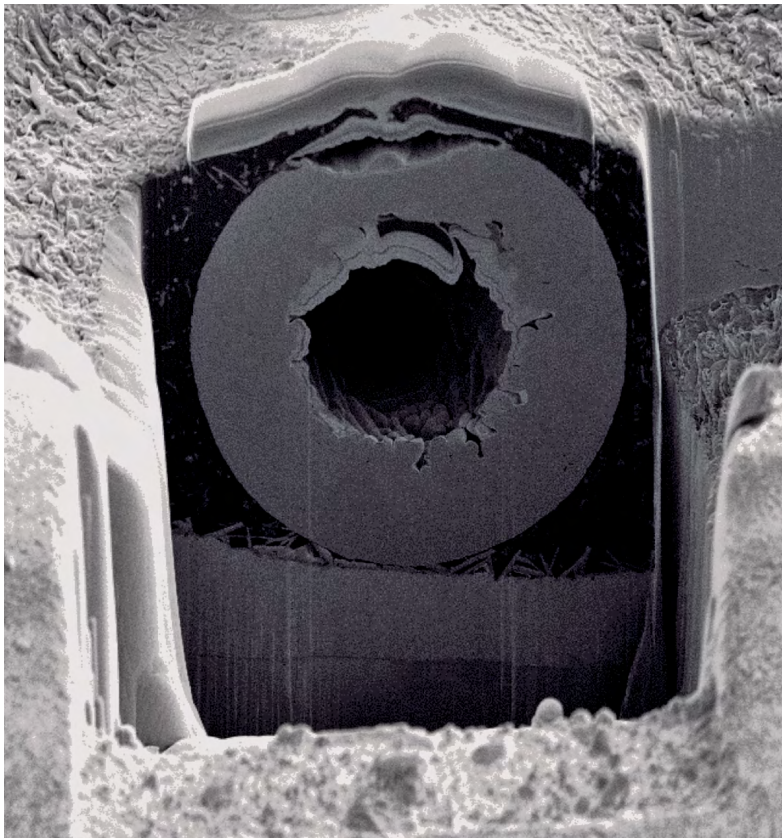

OUR KNOW-HOW

The focus of our work is on organic coatings, their material properties and fields of application. These range from coatings for wood, through wall paints, to functional and decorative paints for the automotive industry.

We specialize in dealing with the following coating defects (examples):

– Defects in substrates

– Delamination, poor adhesion

- Inadequate cleaning processes or surface contamination

– Insufficient substrate pretreatment

– Faulty curing conditions

– Incorrect mixing ratio of a 2-component system

– Contamination in paint materials and coatings

– Mechanical stress on coatings

– Environmental influences

– Typical coating defects, e.g. bubbles, craters, pinholes, particles, etc.

Our testing methods and techniques (examples):

– Infrared spectroscopy to analyze binders and fillers, detect surface contamination, infrared microscopy

– Thermal analysis (DSC, TGA, DMA, STA)

– GC-MS to analyze volatile components

– Determination of the surface energy of substrates (Sessile Drop) and paints (Pendant Drop)

– Laser scanning microscopy

– Scanning electron microscopy (SEM) with energy dispersive X-Ray spectroscopy (EDX), focused ion beam (FIB)

– Rheological investigations

– Raman spectroscopy

– Particle size distribution in paints

– Preparation of cross-sections of defects

Some of these methods are accredited according to DIN EN ISO/IEC 17025.

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CONTACT

Dr. Norbert Pietschmann
Group Manager
Analytics and Materials Testing
Phone +49 711 970-3831
norbert.pietschmann@ipa.fraunhofer.de

Dr. Michael Hilt, MBA
Head of Department
Coating Systems and Painting Technology
Phone +49 711 970-3820
michael.hilt@ipa.fraunhofer.de

Fraunhofer Institute for
Manufacturing Engineering and Automation IPA
Allmandring 37
70569 Stuttgart
Germany
www.ipa.fraunhofer.de

Directors
Prof. Dr.-Ing. Thomas Bauernhansl
Prof. Dr.-Ing. Alexander Sauer

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