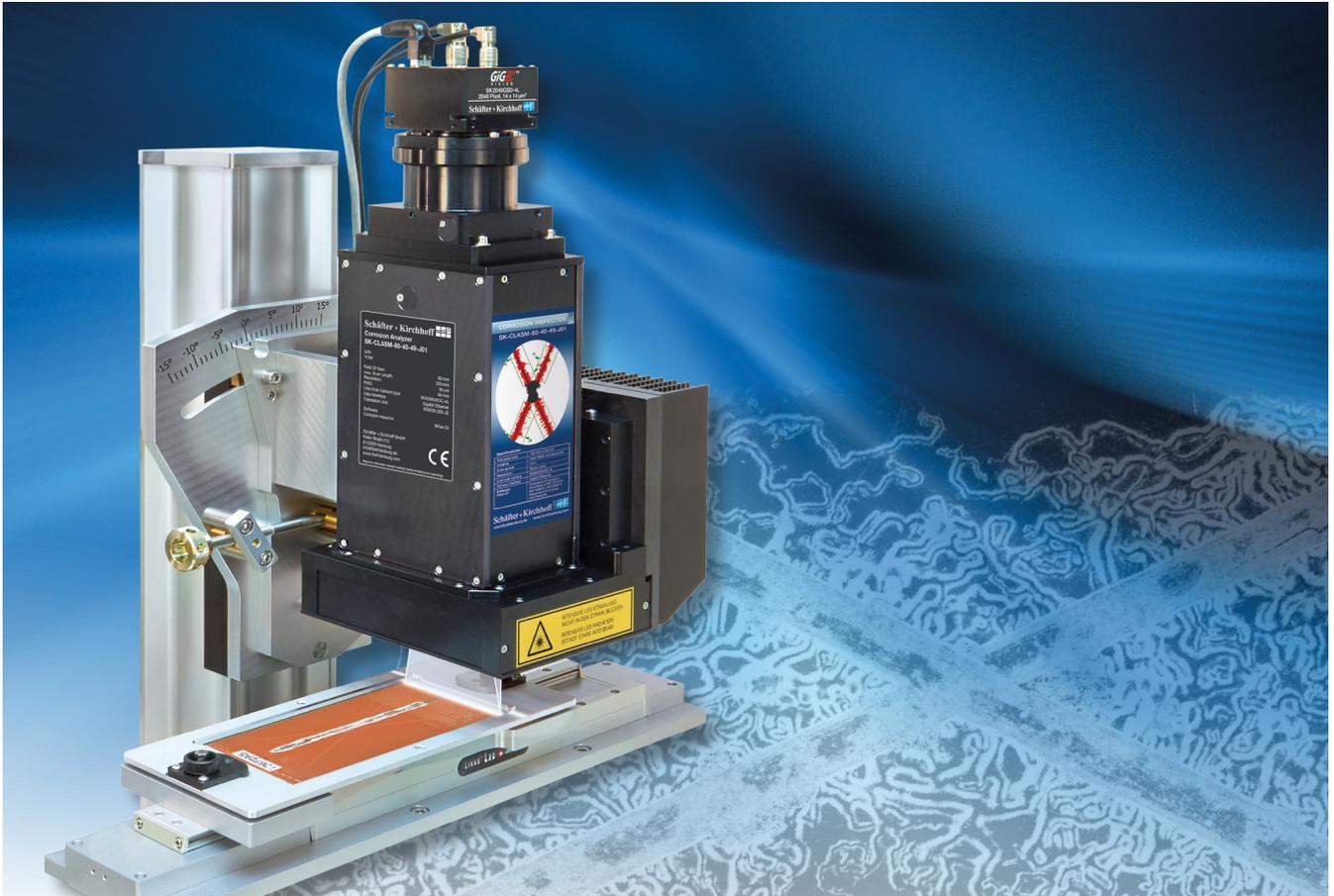


Automation of corrosion test evaluation

Solved cut by cut – new method for automatic cross-cut evaluation

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The Corrosion Inspector scans a standardized test panel in only 0.8 s and with a resolution of 22 μm per pixel.

A new measurement method implemented in the Corrosion Inspector by Schäfter+Kirchhoff for the automatic evaluation of coating properties is currently being investigated at Fraunhofer IPA. The method relies on the latest technologies for optical scanning and quantitative evaluation of changes in coated samples after subject to corrosion or mechanical stress during application tests.

A large number of test panels is generated during the development and quality assurance of coating systems. These are subjected to various tests to evaluate the overall performance of the system consisting of substrate, pretreatment and coating. Up to now, it has been common practice to evaluate many coating properties manually or visually both in the unstressed initial state and after subject to corrosion. Since these tests involve several parallel samples on coated test panels, the evaluation of the test results is very time-consuming, error-prone and subjective.

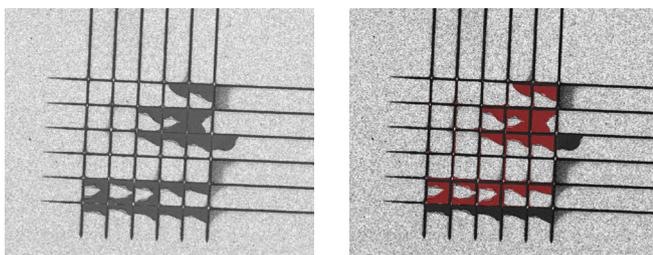
This is where the specific need for new testing methods comes in, which must meet two important requirements: to enable objective evaluation of the application tests on the one hand and to contribute to a considerable rationalization of the testing effort by automating the evaluation process and generating digitized results on the other. In close cooperation with the Fraunhofer IPA, the Corrosion Inspector, a measuring system for the rapid and objective evaluation of corrosion phenomena, was further tailored to the high demands of the coatings industry and its capabilities were expanded. The newly added procedures additionally allow the quantitative evaluation of cross-cut testing and edge corrosion.

The Corrosion Inspector scans a standardized test panel and delivers a very high-contrast image with a resolution of 0.022 mm per pixel in only 1.2 sec. Using the automatic procedure, the evaluation of a sample panel, including documentation and image storage, is completed in 5 sec. In addition to the time

savings, the system is characterized by the variety of implemented evaluation methods. This includes for example:

- Cross-cut classification according to DIN EN ISO 2409
- Edge corrosion characteristic according to MBN 10494-6
- Filiform corrosion according to ISO 21227-4 with counting and length measurement of threads
- Degree of delamination and corrosion according to ISO 4628-8
- Blistering according to DIN EN ISO 4628-2
- Stone impact resistance test according to DIN EN ISO 20567-1

For the evaluation of the cross-cut test, a region of interest (ROI) only has to be placed around the cross-cut after image acquisition. The system automatically detects the delaminated (partial) areas in a very short time and immediately gives the result as the sum of the delaminated areas as well as the cross-cut classification (Figure 1). For the evaluation of the edge corrosion of a test panel that has been exposed to a corrosive environment, a measuring adapter was specially designed for the Fraunhofer IPA, which allows to image the complete panel including edges. The evaluation is carried out in accordance with the MBN 10494-6 standard. The evaluation algorithm determines the corrosion area emanating from the edge of the test panel and calculates the characteristic edge corrosion value KR for this surface in relation to a defined ROI around the edge of the test panel (Figure 2).



Cross-cut analysis

Date: 29.04.2021 / 17:04:20

Order: Article
Exposure time: 800h
Inspector: Mustermann

| | | | |
|---------------------|---------------------------|----------------------------|-----------|
| Specimen ID: | 01 | SK angle: 0 | |
| ID | A [mm²] | AD [mm²] | Gt |
| 1 | 76,33 | 21,29 | 3,00 |

Fig. 1:
Cross-cut test, delaminated areas are marked in red.

Filiform corrosion

The original and first application of the Corrosion Inspector was the evaluation of filiform corrosion [1]. This procedure also continues to develop. It is, for example, now possible to define several arbitrarily shaped ROIs on a test panel, for which the filiform corrosion is evaluated separately. Figure 3 shows a corrosion test panel with three scribes under 45°. On the left side, the plate was polished, but not on the right side. The filiform corrosion significantly differs.

The measurement results are displayed graphically and numerically on the monitor. For each measurement, the operator enters documenting process data, such as name of the inspector, test method, exposure time and specimen ID via a dialog mask. For serial measurements, the specimen ID

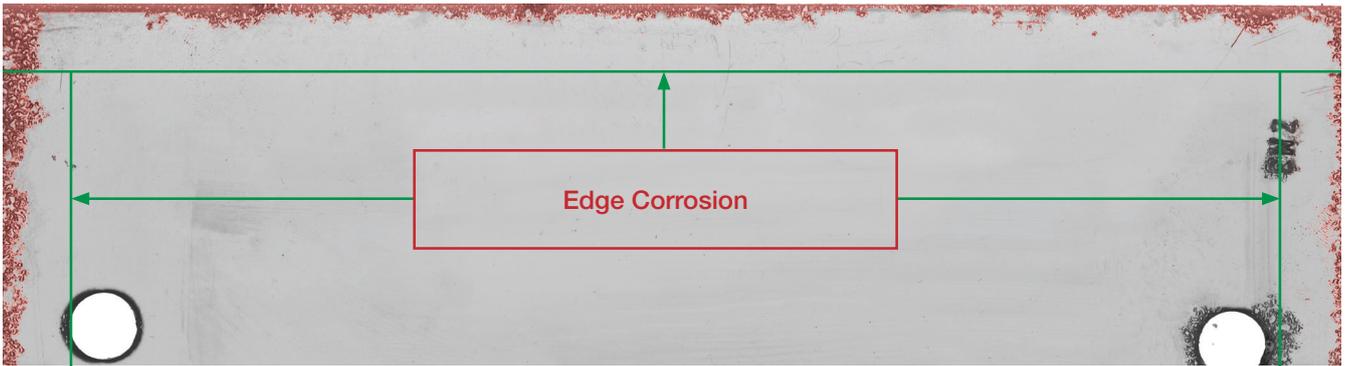


Fig. 2:

Edge corrosion, image and result superimposed, the corrosion areas are marked in red.

is automatically incremented after each new scan. In the data export, the Corrosion Inspector saves the result image together with the original image and the overlaid image as well as an Excel or Calc spreadsheet (LibreOffice) in the selected folder. In addition, the program documents all image processing operations performed that led to this result in order to ensure the reproducibility of the measurement results. The Corrosion Inspector also offers convenient tools for manual measurements, with which even the smallest details can be recognized and evaluated on the monitor in the enlarged view.

imaging quality of the system also allows convenient interactive measurement of corrosion phenomena. This measurement and evaluation method is now mature enough to be used routinely in research and development as well as in quality control. In addition, further customer-specific adaptations of the evaluation procedures are also possible.

[1] Schäfter+Kirchhoff GmbH: On the trail of rust, https://www.sukhamburg.com/support/technotes/linescancamera/applications/art_corrosioninspector.html

Conclusion

The Corrosion Inspector is used for fast and objective evaluation of a wide variety of coating tests and corrosion phenomena on coated test panels. The scanning time for a standardized test panel with a size of 100 mm x 200 mm is 1.2 sec. The automatic evaluation of corrosion according to different relevant standards takes about 5 sec for one sample. The high

Advantages for Coaters

- Objective, standard-compliant evaluation of tests
- Reproducibility of tests and evaluations
- Automated evaluation of samples
- Faster evaluation and digital documentation

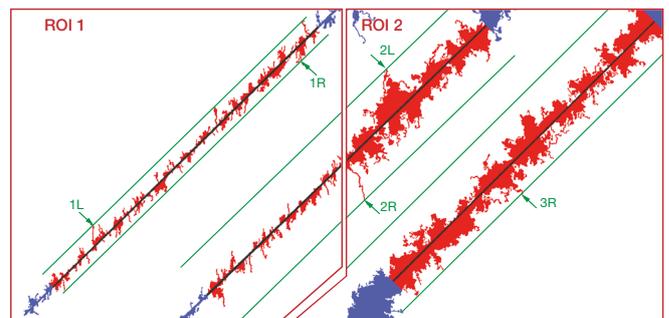


Fig. 3:

Filiform corrosion and evaluation in separate ROIs.