imanto
imaging tools

2

CONTACTLESS EVIDENCE OF BIOCIDES IN CULTURAL PRODUCTS AND TIMBER

THE TASK

Many museums in Germany are not able to present their valuable exhibits to the public because the artifacts are contaminated with biocides. In the 1970s, good-faith efforts were made to prevent textile, wooden or prepared biological objects from being destroyed by spraying them with pesticides, such as Hylotox. Today we know that these substances carry a non-negligible health risk. Exact knowledge of the type, the volume and the location of the contamination are preconditions to determine an optimal cleaning strategy.

To find organic biocides, which altogether consist of the elements carbon, hydrogen and chlorine, a technology is necessary which is able to distinguish substances according to their molecular structure. Non-destructive near- infrared hyperspectral imaging, which makes possible quick spatially resolved and spectroscopic recording of the researched objects, can solve these problems.

HSI microscope combination for detailed investigation of minimal sample areas

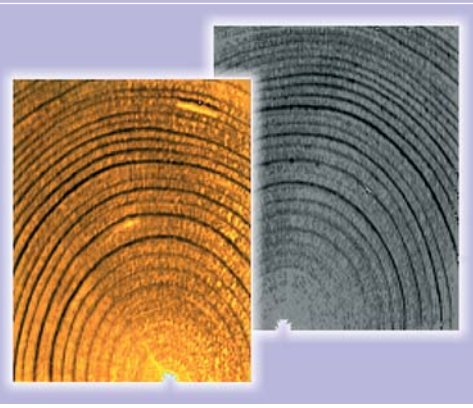
1

OUR SOLUTION

"Hyperspectral Imaging" (HSI) is a class of imaging spectrometers. Apart from laboratory applications, the compact HSI systems are also suitable for analyses on-site, without removing a sample and separately analyzing it in the laboratory. The optically contactless working principle is a major advantage in comparison with invasive inspection methods, since the cultural products investigated are not damaged by them.

Using an adaptable optical system, a wide range of working distances is feasible. A careful choice of the optical unit means that pixel resolutions of less than one micrometer to several decimeters can be implemented. Given the high level of detailed information in spectral monitoring, there is a substantially extended database for sample analysis. In addition to the chemical information recorded in the near infrared range (NIR), image data from the analysis of surface structures can also be used. It is crucial to reasonably process and interpret huge data volumes in the Gigabyte per second range.

At Fraunhofer IWS, solutions that make it possible to quickly derive information by means of multivariate data analysis algorithms, as well as image analysis methods ("soft modeling") were developed. When using the latter in particular, a quick analytical functionality can be realized that is able to analyze the data within a few seconds and to output the result. For this purpose, the software platform (imanto®pro) has been developed in-house, which can be individually tailored to the needs of each task.



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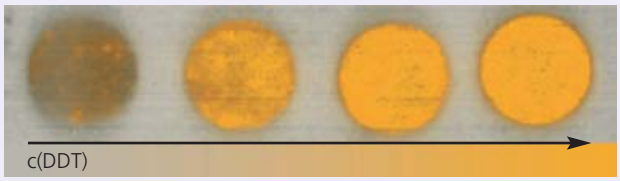
RESULTS

In preliminary studies performed on intentionally contaminated PTFE pressed parts, it was found that the biocides pentachlorphenol (PCP), g-hexachlorcyclohexane (Lindane), dichlordiphenyl trichlorethane (DDT) and parathion can be unambiguously identified with the technique.

PTFE pressed parts with increasing DDT concentration (from left to right), heterogeneous distribution at lower concentrations is clearly visible (minimal concentration < 0.5 weight percent)



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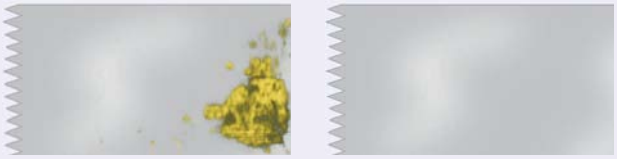
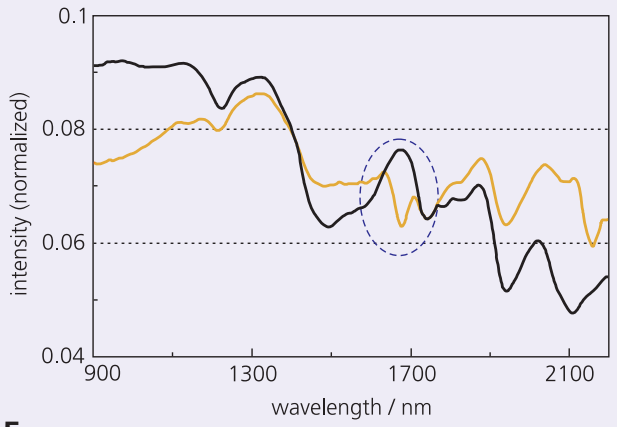
The technique was also used successfully to find biocides on impregnated timber. Biocides were found by means of spectral bands in the near infrared range that can be clearly assigned to the corresponding biocides. Based on a calibrating concentration series (for example in PTFE pressed parts), it is also possible to specify concentrations. An analysis via soft-modeling methods can be, for example, implemented by the principal component analysis (PCA).

In addition to the direct studies of the cultural products, it has also been successfully used to remove surface coatings and analyze them in laboratory afterwards. The coatings crystallized on the surfaces, can, for instance, be removed by means of adhesive tape. Figure 5 depicts samples obtained from a church roof in comparison (contaminated – not contaminated), as well as characteristic spectra.

Adhesive tape-removed sample from a church roof (left) in comparison with a reference sample (right). DDT contamination of the roof sample clearly to be seen (colored in yellow).



Spectra of reference (black) and of DDT contamination (yellow). Blue marked -DDT absorption, which is used for further analysis of the spectra.



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2 Detailed view of illumination in laboratory setup

3 Spectral images of pine cross sections at 1430 nm, with/ without biocide impact

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