

Decontamination of biocidal loaded wooden artworks by means of laser and plasma processing

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Many wooden artworks are contaminated by DDT (dichlorodiphenyltrichloroethane) as a result of a surface treatment by means of Hylotox-59[®]. The liquid preservative was used until the end of the 80s. DDT crystal structures are formed on the wood surfaces by the "blooming" of chlorine compounds. In addition to an aesthetic disturbance, it is assumed that DDT represents a health risk since it is absorbed through the air. Even decades after applying, the toxins in the wood preservatives are still detectable because they are of low volatility in many wood samples.

Contaminated waste wood with natural biocide ageing, gilded and wood carved elements of an old picture frame and wooden samples with paint layers were provided by the Schlossmuseum Sondershausen.

A non-contact procedure by using laser technology appears reasonable, since initially the most heavily contaminated top layer of wood can be treated by this method. Experiments mainly focus on health and safety issues for the operator. The removal of DDT was evaluated employing femtosecond and nanosecond laser radiation and cold atmospheric plasma technique using different working gases (air, nitrogen, and argon).

Before laser application, a chlorine measurement is done by X-ray fluorescence (XRF) analysis as reference. After laser processing, the XRF analysis is used again at the same surface position to determine depletion rates. Additionally, a documentation and characterization of the sample surface is done before and after laser and plasma treatment using optical microscopy. For plasma processing with various systems a chlorine measurement is done by gas chromatographic-mass spectrometry (GCMS) analysis.

For laser treatment a depletion of the chlorine concentration of 55-70% and 75% was achieved for 1064-nm nanosecond pulses and 800-nm femtosecond pulses, respectively. For the application of 30-fs laser pulses, no crystalline DDT residues remain on the sample surfaces. This holds also for the plasma processing with nitrogen as working gas.

After laser and plasma treatment, it shall be recorded in long-term observations, to what extent the remaining DDT residues in the wood possibly efflorescence again.