Abstract

Infrared and fluorescence diagnostics
of paper discoloration under laser irradiation

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In modern world, laser methods are widely used for diagnostics and cleaning of historical paper documents, since the paper exhibits strong modification and degradation with time due to the influence of surrounding medium. This accounts for the topicality of the problems of paper preservation and restoration.

In this work, the effect of laser radiation on a German geographic map printed in 1846 is considered. The sample is irradiated with pulsed and cw radiation at a wavelength of 532 nm and several fluences. The visible bleaching resulting from the pulsed irradiation (wavelength, 532 nm; power, 3 W; mean intensity, 1 W/cm^2; pulse duration, 5 ns; repetition rate, 10 Hz; and pulse energy, 55 mJ) is demonstrated. Cw irradiation (wavelength, 532 nm; power, 0.1 W; and fluence, 9 kJ/cm^2) does not cause visible bleaching. The changes of the bleached map after 5 years are discussed.

ATR FTIR and fluorescence spectroscopy are used for diagnostics. Comparison of ATR FTIR spectra shows differences in the interval 1500-1800 cm^{-1}. Spectra in this range are approximated using the Lorentzian bands peaked at 1545, 1578, 1600, 1621, 1640, 1665, 1686, and 1735 cm^{-1} that correspond to oscillations of known molecules and molecular groups (lignin, COO-, C=C, -OH, C=C-C=O, C=O, -COOH).

Variations in colors of samples are measured in CIE Lab coordinates.

Scanning Electron Microscopy is used to study paper topography. It is shown that the pulsed irradiation with a pulse energy of 200 mJ can lead to laser ablation.

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