

Using THz-TDI for Identification of Paint Layer Delamination and Control of its Consolidation

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Abstract—Samples mimicking delamination of preparation and paint layer on a panel and canvas painting were prepared. They were investigated in reflection geometry using THz-TDI before and after consolidation treatment. Regions of delamination and successful consolidation could be identified. The results present a promising starting point for the planned inspection of a painting which is awaiting restoration.

I. INTRODUCTION

TERAHERTZ (THz) spectroscopy and THz imaging has already been employed for investigation of different cultural heritage [1], [2] as the main benefit of THz investigation compared to e.g. UV-VIS, NIR investigation is its capability of revealing deeper parts of a sample. Compared to x-ray investigation it is non-ionizing and, in some cases, offers better discrimination between thin images from different layers [3]. In this study we employ THz time-domain spectroscopy imaging (TDI) for the investigation of paint layer delamination and its consolidation on mock-up samples mimicking a painting on canvas and wood.

II. EXPERIMENTAL PART

In total 36 samples (50x100 mm²), 18 mimicking a panel painting and 18 mimicking an easel painting were prepared. In total three different painting media were used (acrylic, tempera and oil) resulting in six sets of six samples prepared in an identical way. The paint layer consisting of paint and preparation were glued to the wood or canvas support only at equidistant points with spacing of approx. 10 mm in order to induce delamination. All the samples were investigated using THz TDI in reflection geometry with a robotic system [4], before and after consolidation treatment. Different consolidation techniques were used for the samples prepared in the identical way.

The two THz measurements, before and after consolidation, were compared as follows. For each pixel of the measurement after, the corresponding pixel before the consolidation and its eight closest neighbors were selected. Then their spectra between 0.2 and 2 THz were compared by calculating correlation coefficient (CC) resulting in nine values, which were averaged and subtracted from 1. In this abstract we show the results for a single sample.

III. RESULTS

In Fig. 1 a) photo of a sample after consolidation is shown and in Fig 1 b) a false color image of CC of the THz spectra before and after the consolidation treatment. Several areas with bigger values of 1-CC (i.e. bigger difference) can be identified as red and yellow parts of the image. For one such area in the top right-hand part of the image, a cross-section analysis (B-scan) along x- and y-axis was performed. In this case the THz time-domain data reveal the cross-sectional information about the sample. The B-scans along x- and y-axis before and after consolidation treatment are shown in Fig. 2.

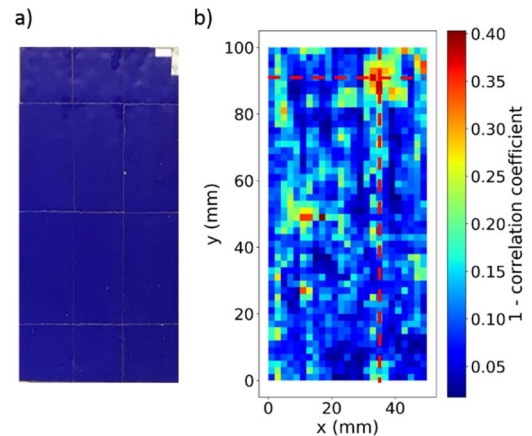


Fig. 1. An acrylic sample with induced delamination. a) Photo of the sample after consolidation. b) False color image of 1 - CC of the THz spectra before and after the consolidation. The red dashed lines indicate the direction of the two cross-section analysis (B-scans).

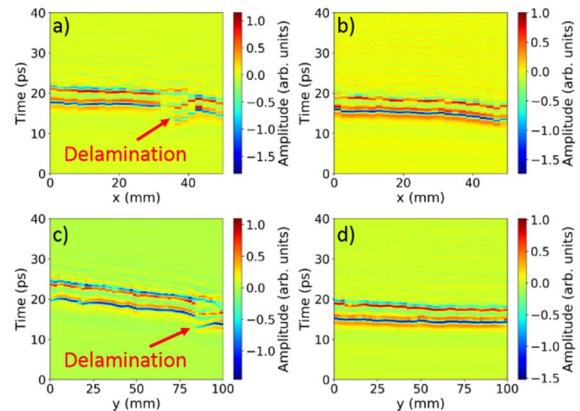


Fig. 2. B-Scans of the sample at $y = 88$ mm a) before and b) after consolidation; and at $x = 32$ mm c) before and d) after consolidation.

Delamination of the sample before the consolidation can be clearly observed from the B-scans. Furthermore, after the sample had been consolidated, the successes of the consolidation treatment could be confirmed using THz-TDI.

IV. SUMMARY

The investigation of samples mimicking an easel painting show the potential of THz TDI for identification of paint layer delamination and control of its consolidation. At the conference results from an investigation of an actual easel painting will be presented.

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