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Abstract

FTIR Analysis Both for Degradation and Treatment with Nanoparticles of Historical Paper †

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Cellulose destruction reactions consist of a series of physico-chemical phenomena, which cause the shortening of macromolecular chains. These reactions occur with the cleavage of the cellulose chains and thus with the decrease of the average degree of their polymerization. They can be caused by both internal and external factors.

The transformations due to internal causes are due to a series of elements related to the molecular, secondary or tertiary structure of cellulose, such as: the existence of defects in the supra-molecular structure, causing the formation of so-called "weak points", or the existence of some internal stresses in the cellulose fiber structure, which occur during repeated drying processes. Degradation reactions can also be caused by the filler compounds existing in historical paper [1].

Destruction reactions resulting from external causes occur under the action of multiple factors: light, temperature, humidity, air pollutants, biological pollutants, mechanical forces, etc. [1].

Historical book papers from the nineteenth to the twentieth centuries, without heritage value, cellulose, ethyl cellulose and carboxymethyl cellulose standards were analyzed. The FTIR spectra were registered on a Perkin Elmer GX spectrometer, both in transmission and attenuated total reflection ATR, spectroscopy analytical techniques.

The restoration and conservation of artifacts with nanomaterials is a new and insufficiently explored area.

Globally in the last 20 years, particles of Ca or Mg hydroxide nanomaterials have been applied in non-aqueous dispersions to cellulose-based artefacts, with the idea of achieving deacidification. However, these complexes have the disadvantage of having an overly strong alkaline character [2,3].

This study is based on the use of hydroxyapatite (HA) as a historical paper conservation material. The similar structure of HA with that of the phosphates found in the paper, either as fillers or as impurities accompanying the component materials of the paper, has led to the certain conclusion that there is a perfect compatibility between this material of conservation and restoration and the paper support [4,5].

FTIR methods have been applied for the study of degraded paper as well as for historical paper treated with HA. To assign the FTIR absorption bands in the historical paper samples, different standards were used, including cellulose, ethyl cellulose and carboxymethyl cellulose standards.

After treating the historical paper samples with HA, they were subjected to FTIR analysis, and the next step was a comparison between the treated and untreated samples.

It is very difficult to establish the existence of FTIR differences between the untreated historical paper and the one treated with HA nanoparticles—on the one hand due to the very small amount of HA deposits, and on the other hand due to the perfect similarity between the treatment material and

the phosphates already existing in the paper. However, upon careful examination, small differences were noted between the untreated and treated papers.

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