

ANALYSIS OF VOC FROM PAPER AND MACROMOLECULAR CHARACTERISATION OF CELLULOSE: AN INTEGRATED APPROACH TO PAPER DEGRADATION

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The aim of this ongoing research is to investigate possible correlations between two levels of chemical degradation of cellulose, the macromolecular level, particular to the polymer, and the molecular level, which leads to the formation of volatile organic compounds (VOC), end-products from oxidation and hydrolysis reactions of cellulose. The objective of developing an integrated approach for evaluating paper degradation is also to establish novel non-destructive strategies for the diagnostic of the conservation state of works on paper.

Size-Exclusion Chromatography with Multiangle Laser Light Scattering (SEC/MALS) was used for the macromolecular characterisation of cellulose in model papers, unaged and artificially aged. Ultimately it is the average length of the cellulose molecules that governs the physical properties of paper, which are related to the material mechanical resistance and brittleness. However, even though working on a micro-destructive scale is possible, SEC/MALS analysis requires physical sampling of paper, which can become problematic in light of the cultural value of paper documents.

With this consideration in mind, the present work focuses on developing novel non-invasive techniques for the analysis of the VOC produced in the papers during ageing. Solid Phase Microextraction coupled with Gas Chromatography and Mass Spectrometry (SPME-GC/MS) was chosen as a suitable non-destructive technique to fulfil this purpose. The mechanism underlying SPME being based on selective gas phase adsorption of compounds according to their affinity with a polymer coated fibre, the technique has most often been used for qualitative evaluations. In the present work we report on the development of methods for the semi-quantitative assessment of small organic acids and their aldehydes precursors using SPME-GC/MS. Among the degradation products, compounds of interest included formaldehyde, acetaldehyde, the corresponding acids and furfural. These methods involve on-fibre derivatisation. In order to draw correlations and confirm the SPME-GC/MS results, Capillary Zone Electrophoresis (CZE/UV) was also used to identify and quantify the small organic acids in the aqueous extracts from papers using recently developed methods.