

Role of cellulose oxidation in the yellowing of ancient paper

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The hue of the yellowish color in ancient paper may be placed in precise relationship with the environmental conditions to which the artefacts were exposed during their life. This important outcome is the result of our experimental and theoretical investigation on the optical degradation of 15th century papers.

Paper degradation results in a yellowing of the sheets mainly as a consequence of the oxidation of cellulose fibres. The oxidized products act as chromophores capable of selectively absorbing light and give rise to the yellow coloration of ancient paper sheets. The complex chemical and physical properties of cellulose have prevented a detailed identification of chromophores up to now.

To solve this problem, we measured the optical properties of both ancient and, as comparison, modern paper samples artificially-aged in several environmental conditions and interpreted the collected data by means of ab-initio theoretical calculations based on time-dependent density functional theory. Through this approach the relative concentrations of chromophores responsible for the yellowing of the ancient paper were clearly identified and quantified. A given set of chromophores produced upon aging is strongly related to the environmental conditions to which the artefacts were exposed during their life, such as dry, humid or closed storage.

Our work contributes to a contemporary Preservation Science which attempts to provide conservators a rationale based methods of artefacts analysis and treatment.