Formulation of hydrogel for the removal of polymer resins used in the restoration of artifacts of historical and artistic interest

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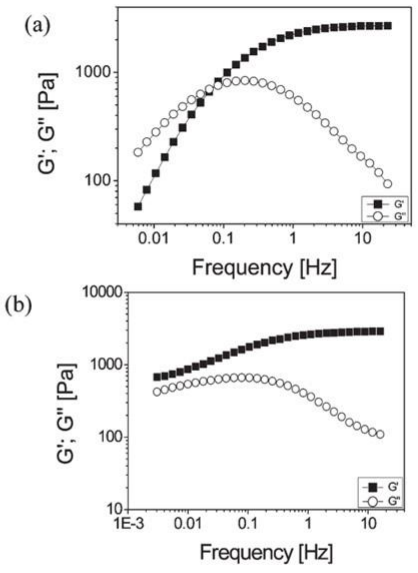
Restoration interventions aim to target the conservation of the work in all its parts, opting for minimal intervention and minimal complexity of the work. The degradation of the materials constituting the works is considered a natural and inevitable physiological phenomenon, but the products to be used during restoration interventions should be and compatible with the materials of the artifact to which they are applied, stable from the point of view of aging since their degradation could accelerate the process of degradation of the work itself. Most importantly, the restoriation material should be reversible in the event that the need arises to remove the previous restoration in order to carry out another one with different modalities.



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The degradation process of polymer resins, widely used as restoration materials, consists of chemical transformations due to the action of factors such as light, temperature, interactions with the substrate, and air pollution. Such transformations can be triggered by chemical processes as the cross-linking of polymer chains (cross-linking), their breakage (chain scission) or their oxidation. The simultaneous action of these secondary factors leads, over time, to phenomena of film embrittlement, decreased solubility, yellowing of the resin, increased polarity, and decreased adhesive strength. For the reasons just described, it is clear that, if degraded, polymer films can cause irreversible damage to works of art, drastically altering the physicochemical properties of the surface to which they have been applied, becoming increasingly resistant to common solvents, thus limiting their reversibility. For this reason, the removal of old restoration products from works of art is one of the most important operations to be implemented during restoration work, provided that this operation is conducted with full respect for the work and its constituent materials.

In recent decades, hydrogels have been used as low-impact cleaning tools for painted surfaces. Their growing popularity stems, in large part, from the possibility of exerting better control of the cleaning action than it is possible using free solvents. The aim of the present project is primarily to gain an in-depth understanding from a chemical-physical and rheological point of view of hydrogels for cleaning artifacts of historical-artistic interest, focusing on the behavior of these systems as a function of relevant parameters such as solvent concentration, temperature, pH, and the interaction with the supports to which they are applied. The systems will be studied in depth to investigate their timing and mode of release of solvents suitable for the removal of oxidized resins present on the artifacts, wettability, and the timing of solubilization and removal of the resins from the art support. The objective is to study hydrogel formulations currently used in the field of cultural heritage restoration and their rheological characterization, optimization of mechanical properties, and analysis of phase transition as the concentration of polymer and solvent contained within the hydrogel changes. The ultimate goal will be the formulation of a hydrogel with the same physical characteristics as currently used products, but replacing synthetic polymers with other plant-based, biocompatible and biodegradable hydrocolloids that are much safer for art artifacts and restorers. During the first year of the Ph.D. program, the focus will be on an extensive literature search of the main products used for the formulation of hydrogels currently in use. Subsequently, some experiments will be conducted to analyze the rheological characteristics to be reproduced. A protocol will be developed in this regard to ensure the repeatability of the measurements. During the second year of the Ph.D. program, the focus will be on gelation kinetics by adjusting parameters such as polymer and solvent concentration; in addition, efforts will be made to formulate alternative hydrogels to those currently popular, which simulate their rheological characteristics. During the final year of the Ph.D. program, the new hydrogel formulations will see their application first on laboratory-prepared specimens and finally on art objects of real historical and artistic interest.

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