

Synchrotron radiation analysis of parchment degradation

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Parchment contains important historical information, from text written on the surface to the structure of the material itself. Whilst deterioration of historical parchments is often attributed to harsh storage conditions, other factors may also accelerate the decay of the collagen structure within parchment, such as harsh cleaning techniques.

X-ray diffraction is a technique capable of non-destructively describing the condition of the structure of collagen within parchment. As such, this technique has been used on valuable documents such as the Dead Sea Scrolls [1]. Recent advances in synchrotron radiation technology has led to more detailed analysis of the parchment structure.

Microfocus X-ray diffraction and fluorescence using a compound refractive lens has allowed for surface-to-surface analysis of cross-sections of parchment samples [2]. Up to 200 images can be taken in a single cross sectional scan of a 300 μm thick parchment section, providing X-ray diffraction analysis of features present only in specific areas of the parchment, such as at the surface. Using this technique, the degradation of collagen through cross sections, the orientation of collagen fibrils, the presence of lipids and minerals and the effects of ink have been described. This analysis has demonstrated that parchment is not a uniform structure in cross-section. The collagen is aligned in the plane of the parchment, with lipids packed between collagen fibrils, suggesting specific lipid-protein interactions, polymorphs of calcite are distributed randomly throughout the cross-sections. Collagen at the parchment surface is damaged in regions immediately underneath writing, suggesting that the ink corrodes the parchment structure.

Microfocus X-ray diffraction coupled with conventional synchrotron radiation analysis has been used to describe the effects of conservation treatments on the collagen structure within parchment. Conventional treatments as well as the new technique of laser cleaning have been analysed by these methods [2,3]. Surface cleaning of parchments with erasers or sponges appears not to adversely affect the structure of the collagen; however, when these are coupled with relaxing techniques such as the use of isopropanol or ultrasonic humidifiers, surface damage of collagen becomes apparent. Laser cleaning using long wavelengths and low energy levels appear not to damage the collagen structure in parchment; however, using ultraviolet wavelengths of light or excessively high energy levels appear to induce gelatinisation of the collagen at the parchment surface.

References

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