MEMORI: Damage to Organic-based Cultural Heritage


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Objectives to evaluate the effects of indoor organic pollutants, acetic and formic acids, on indoor organic-based cultural heritage and recommend methods for the reduction of gaseous pollutant impact on movable cultural assets, facilitating safe use of protective enclosures and demands for energy saving to mitigate climate change.

Damage assessment of parchment

Atomic Force Microscopy (AFM) of parchment

Acetic acid damage

Undamaged

RHT damage

Collagen in unaged parchment regular D-spacing 67nm (A) and after 2 weeks at 80%RH and 40°C Deformation of fibrils occurs (B)

In the IDAP project (Improved Damage Assessment of Parchment) extent of damage e.g gelatinisation was correlated with extent of retained intact D-banding structure.

Quantification of AFM images provided a measure of extent of intact structure. Plot of this parameter (peak area) is shown against shrinkage temperature (Tg).2 Rf value for peak area is consistent with high Rf and intact collagen.

Micro-Thermal Analysis (μ-TA) of parchment

Difference in thermal behaviour of collagen and gelatin2

Before exposure collagen like: after exposure gelatin like

Effect of RH on the mechanical properties of parchment

Displacement (%) vs RH (%)

Parchment pre-dried (24hrs) and exposed to RH (15%/65%)

Acid exposed new parchment (more damaged) i.e. gelatinised has lower displacement and lower rate of expansion than unexposed parchment.

Similar studies are in progress for tanned leather (mimosa and roomac).

Acetic acid within frames (S) and (R) was measured as 479µg/m3; 348µg/m3 respectively (courtesy NILU) which exceed recommended level6

Tariff peaks: Dammar in С (blue), (yellow) and charcoal cloth (pink)

Dynamic Mechanical Analysis (DMA) gives viscoelastic data in terms of tan δ peaks.

Acetic acid is given in the current guideline as a preservation target for object exposure for 1 year. In the PROPAINTER project several sites exceeded this value.

Conclusions

Assessment of acid induced damage to parchment, leather, and varnishes (natural and synthetic) is in progress. For varnishes mechanical data are complemented with gas chromatographic and mass spectrometric (GC/MS) measurements as well as electrospray MS and MALDI-MS and correlations are observed. This has been reported elsewhere1,4,6

For collagen-based materials mechanical behaviour on regain of moisture after drying is used as a marker of damage. This correlates with loss of D-banding structure (gelatinisation) as observed by atomic force microscopy (AFM) and shrinkage temperature. Surface damage to parchment fibres was observed by AFM after 15days at 1500µg/m3 at 74%RH.

From site exposure where values exceeded recommended levels in the case of varnishes an increase in the glass transition temperature values (Tg) and changes in viscoelastic properties occurred.

References: