Influence of coatings on diffusion and sorption properties of wood

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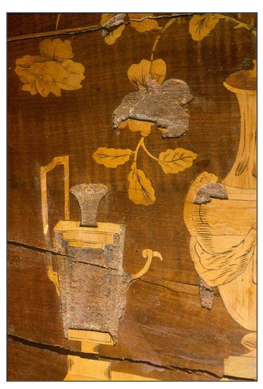
Introduction

Shrinkage and swelling in response to environmental relative humidity changes are responsible for some of the most important conservation problems for cultural heritage objects made of wood. The risk of damages such as cracking and warping of the wood, deterioration of glued joints, delamination of veneer or loss of paint coatings depends also to a great extent on the construction of the object, for example the presence of glued joints restraining movement of individual boards.

It has also been found a disadvantage if the rate of response of one face differs greatly from the other, as it is the case for objects with a varnish or polychrome finish, marquetry or veneer. In a museum context all of these are common, for example with historic furniture or panel paintings. In order to define acceptable humidity fluctuation limits in these cases, sorption and diffusion data for common historic coatings are required.



Figures from left:

Cracked veneered pinewood tabletop, early 19th century, MAH inv. AD 6059

Cracked top of a 16th century violone, MAH inv. IM 65

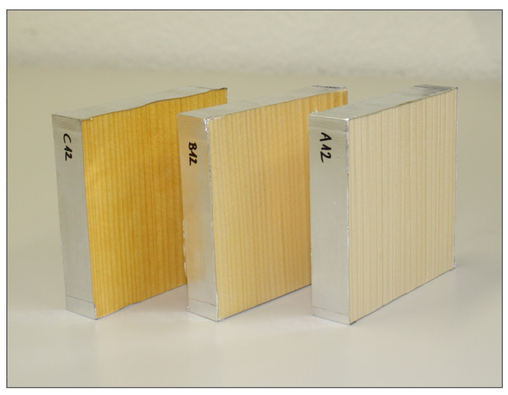
Damaged marquetry on a French 18th century commode, MAH inv. AD 6920 (detail and overall view)

Photos: Pierre Boesiger and Bettina Jacot-Descombes, MAH Geneva

Materials and methods

Experiments with specimens of Norway spruce were carried out to investigate the barrier effect of coatings to humidity absorption. We compared four traditional coatings – turpentine varnish, linseed oil, shellac and a wax coating – with a modern synthetic alkyd-resin varnish and with an uncoated reference specimen.

The specimens, 95×95×20 mm in size (axial, radial, tangential) were coated on both faces (the axial-radial planes). They were first conditioned at 65% relative humidity, then transferred to a climate chamber of 35% RH, always at 20˚C. After reaching equilibrium moisture content, the edges were sealed with aluminium tape, limiting moisture flow to the tangential direction, and specimens were returned to 65% RH.



From this point, the mass increase with time of the specimens was measured. Mass gain per face area (g/m^2) and moisture contents of the wood were calculated from the data.

Here we present results from the first eight weeks of the experiment.

Sorption specimens with sealed edges

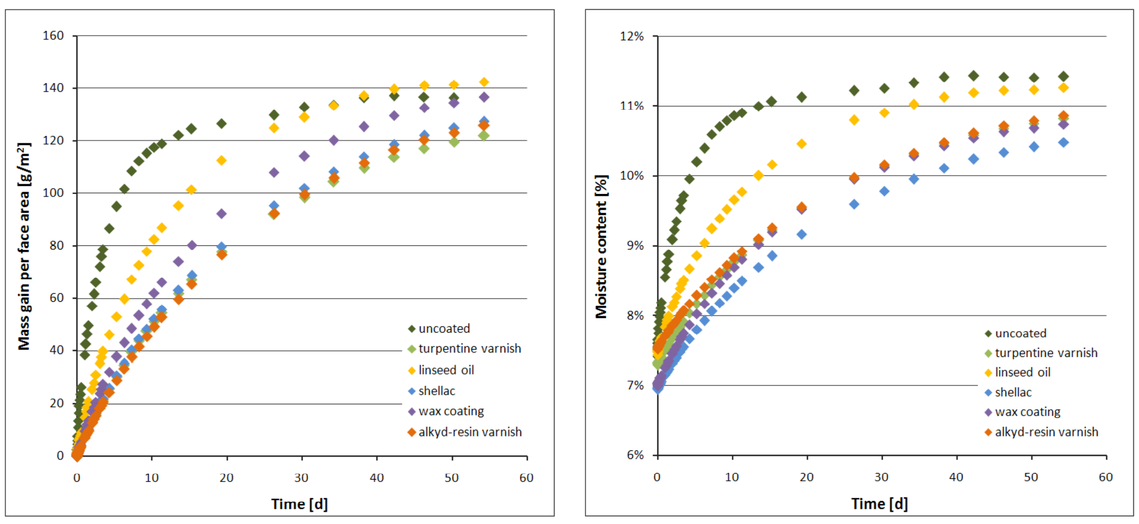
Results and conclusions

The diagrams below show mass gain per face area and moisture contents of the wood as a function of time. Whilst diffusion rates vary to a certain extent between the different coatings, all were found to slow down humidity absorption significantly, even though none of them came close to be an impermeable barrier.

After one month, all coated specimens were still far from equilibrium whilst the uncoated reference did at this point not absorb much more humidity. Only after approximately two months did the coated specimens reach similar humidity levels to the uncoated reference specimen.

Among the coatings investigated in this experiment, turpentine varnish and shellac were found to have similar diffusion properties to the alkyd-resin varnish, closely followed by the wax coating. The linseed oil varnish was significantly more permeable, but still much less so than the uncoated reference specimen.

The results demonstrate and quantify the mitigating effect of varnishes on the reaction of wooden objects towards short and medium term environmental humidity fluctuations. Humidity absorption into uncoated surfaces happens significantly faster, which may introduce additional stress in only partly varnished objects, such as furniture with exposed rear or undersides.



Mass gain per face area (left) and moisture content (right) of coated wood specimens as a function of time

Acknowledgments

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