

Paint Dosimeters as Tools to Monitor Museum Environments

Dedicated to the memory of Professor Dr.J.J.Boon

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Alcázar, Segovia, Es (ALC)



Rijksmuseum store, NI (RDO)



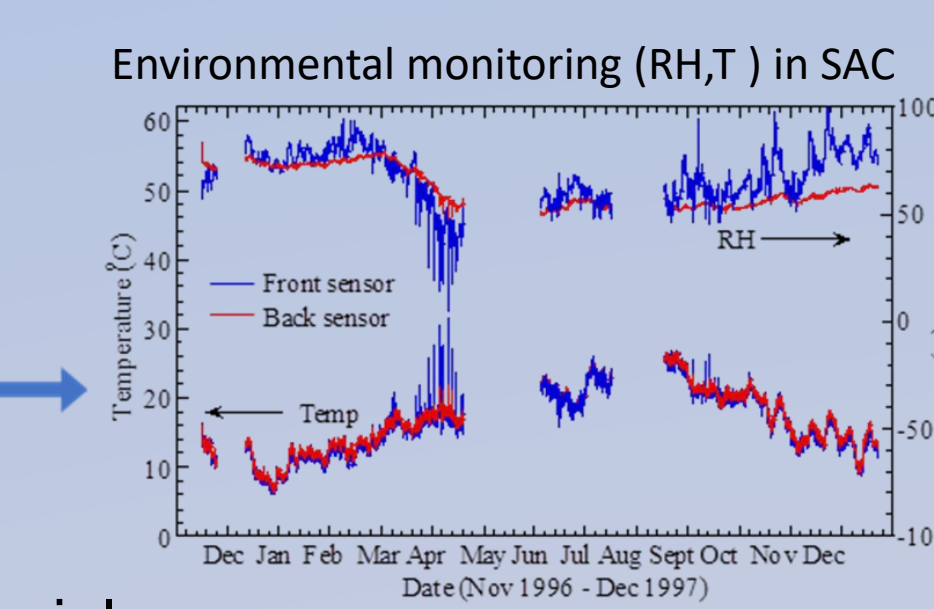
Tate Britain, UK. (TAT)



Uffizi, It UFF



Sandham Memorial Chapel, UK (SAC)



Whole egg & mastic Melinex substrate

The ERA team in front of Sandham Memorial Chapel (UK)

Looking back : Purpose and scope

The aim of the ERA project was to develop a risk assessment tool to evaluate the indoor air quality of museum environments.

Novelty: first paint dosimeters in use in museums and multi-analytical approach used for their evaluation. This approach was used later in outdoor exposures¹

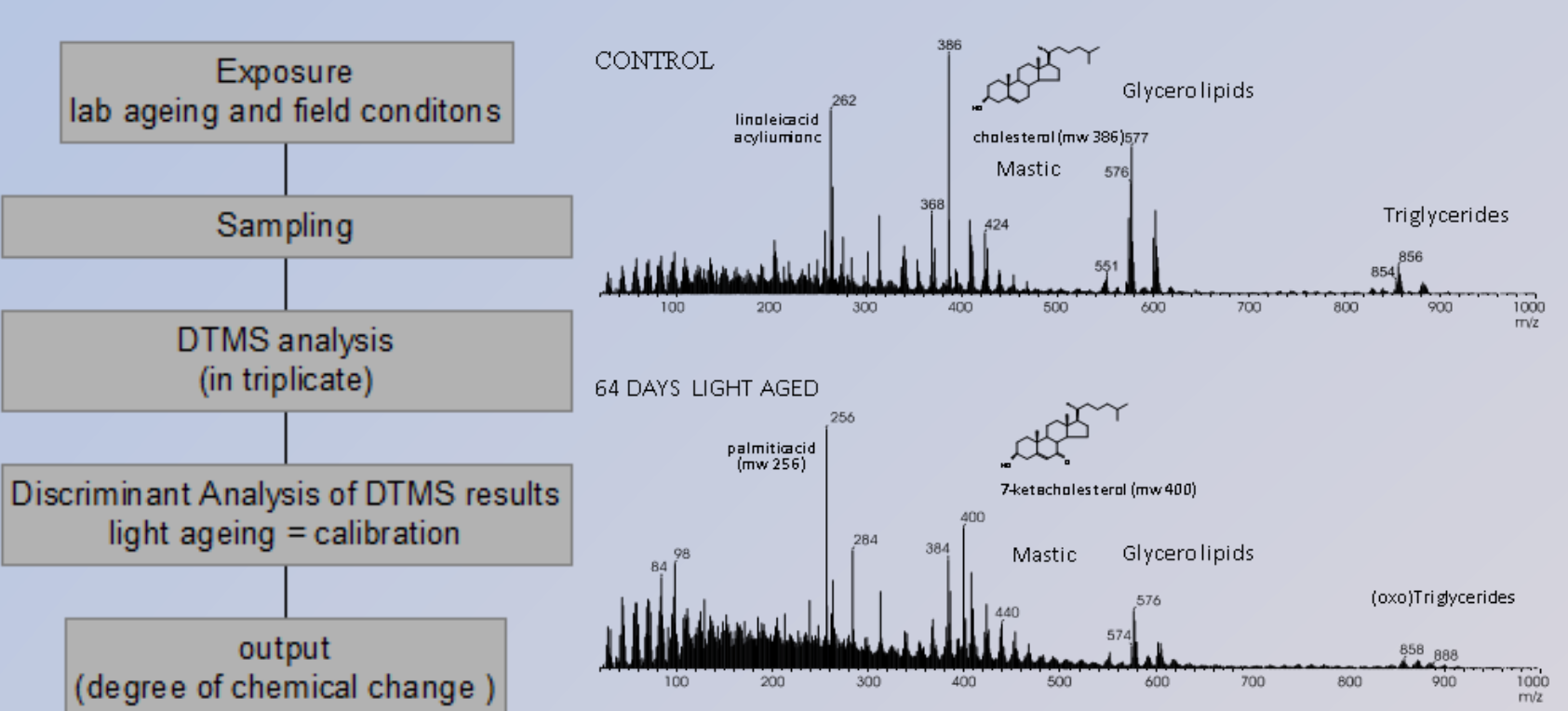
Current Objectives

➤to highlight outcomes of the ERA project: chemical changes in paint tempera dosimeters correlated with air quality of indoor museum environments

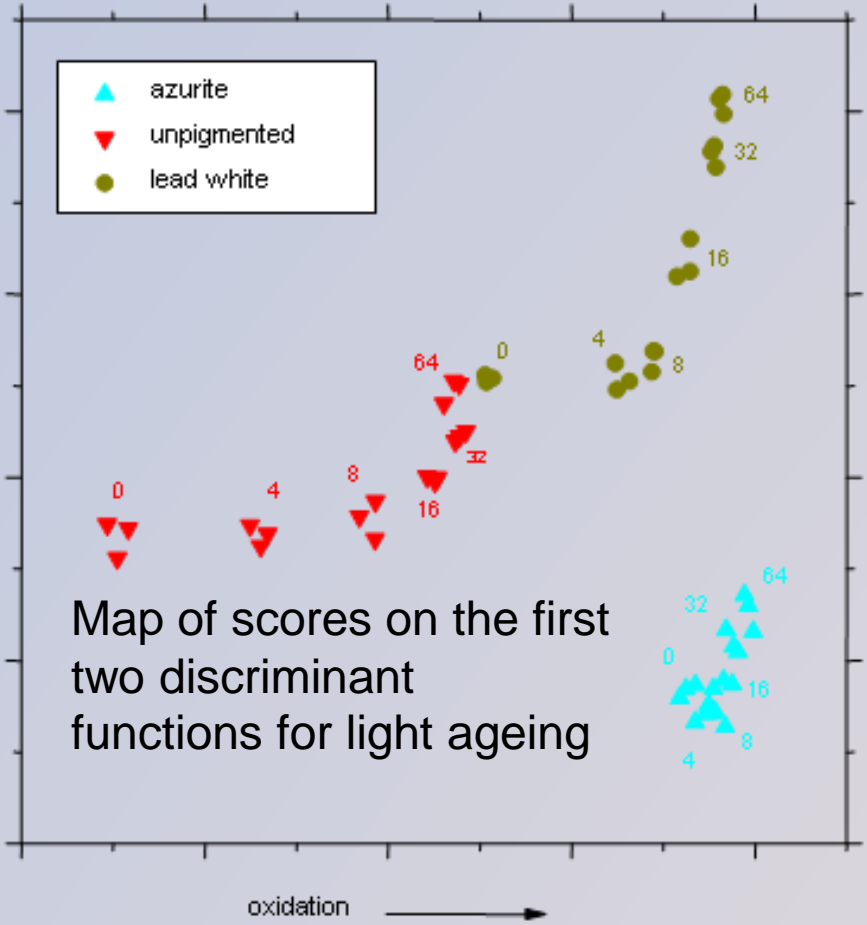
➤to demonstrate use of AKTS Thermokinetics software² for sparse data using the accelerated light ageing data sets obtained from Dynamic Mechanical (DMA) measurements.

To quote Robert Feller³ “ it is important that the degradation profile (kinetics of degradation) be understood when retarding of degradation is an aim”

Results

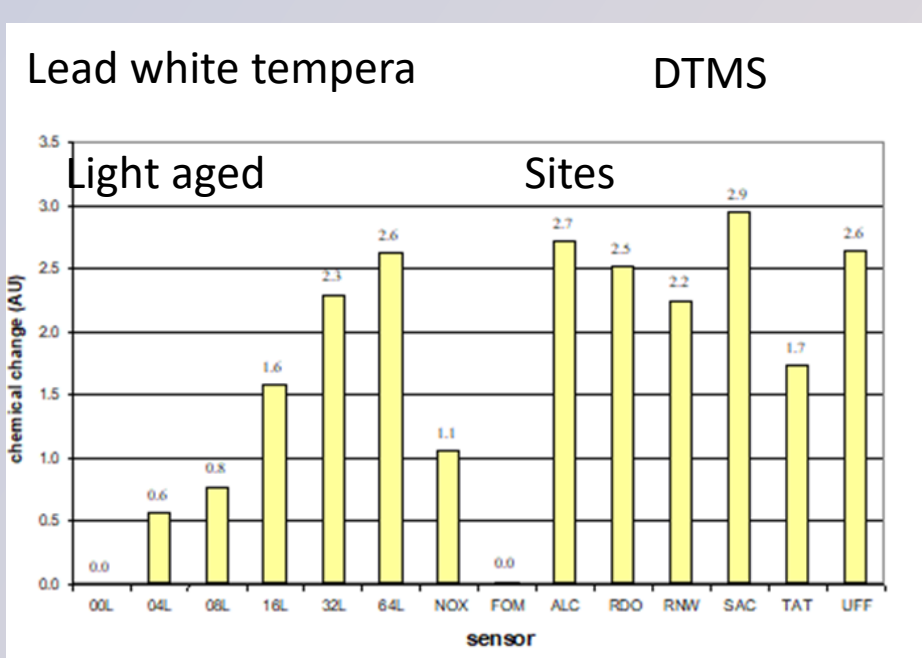


Highlight findings of ERA project

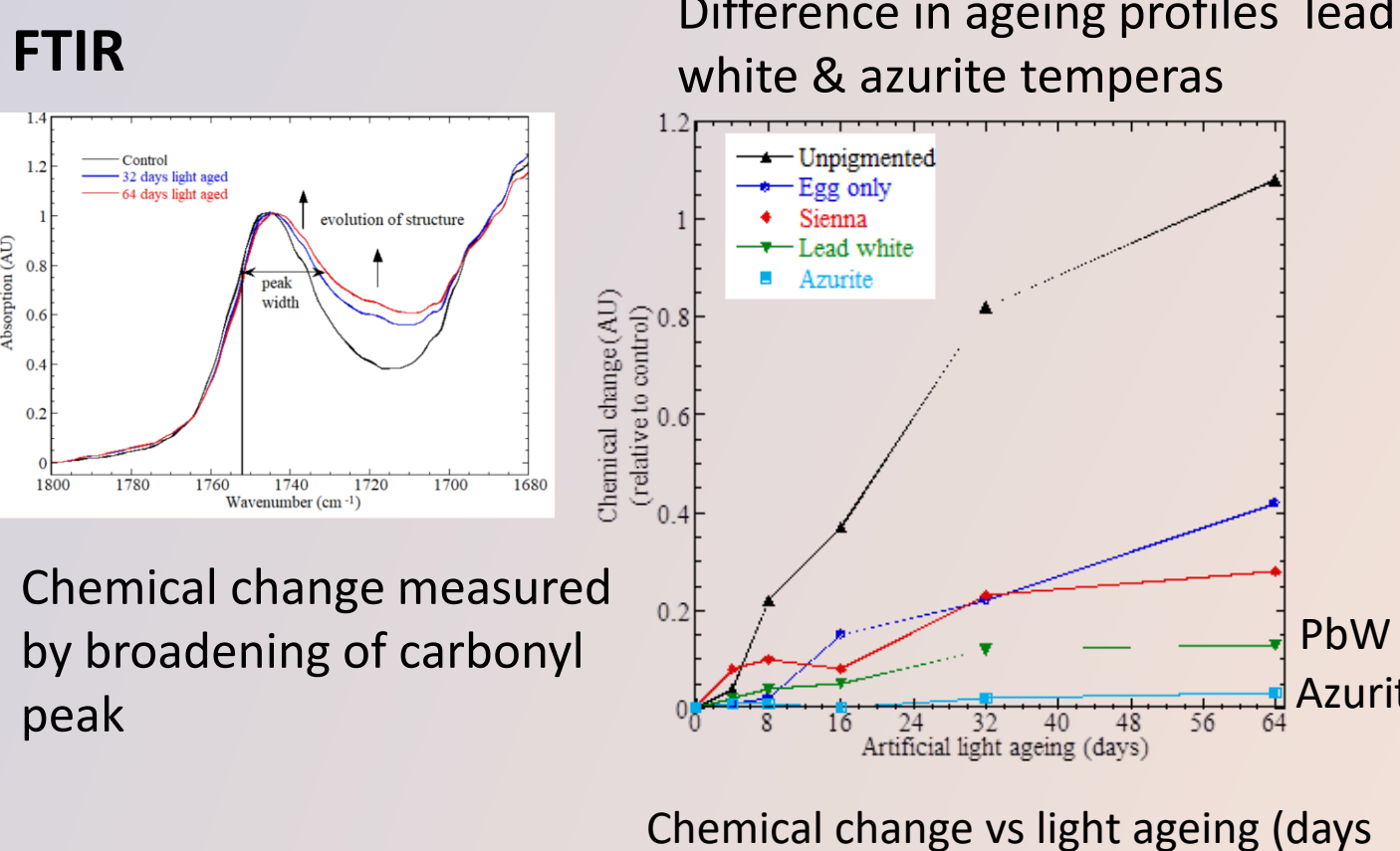


Degree of oxidation of azurite binding medium is very high.

Degree of hydrolysis is relatively low compared to lead white pigmented systems⁴



Degree of chemical change of light aged & site exposed lead white tempera⁴



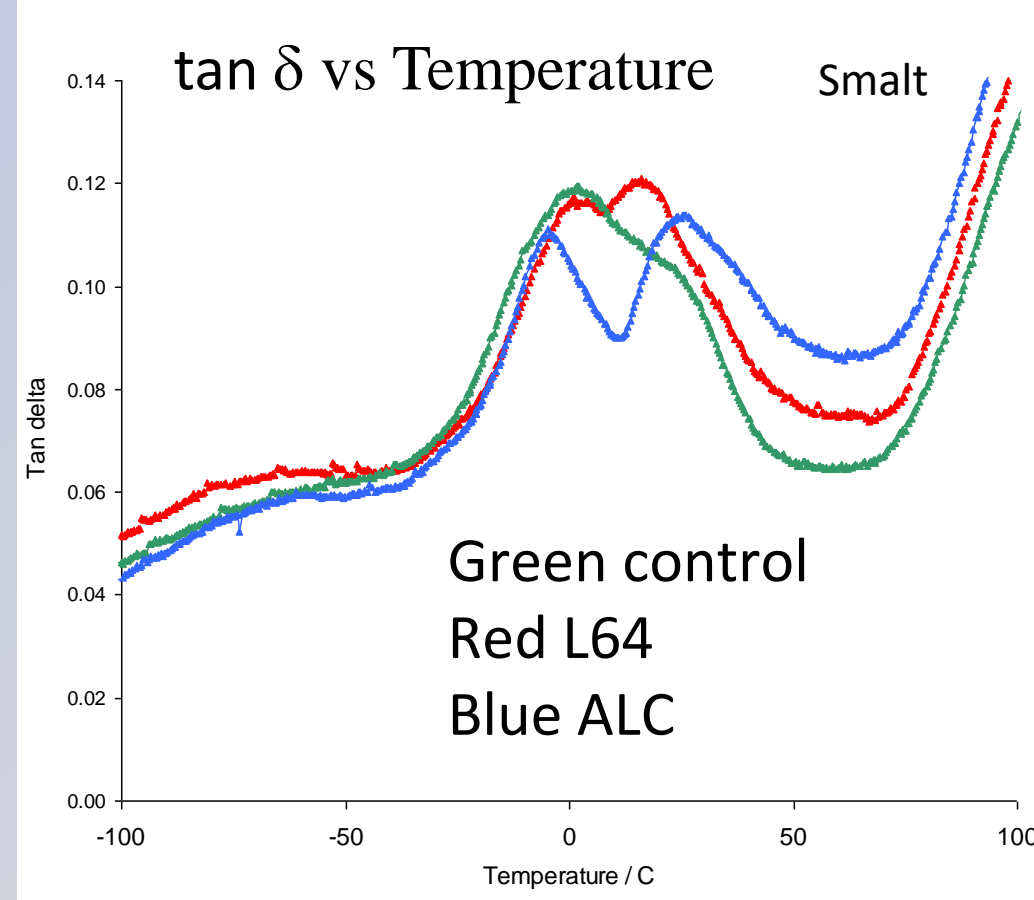
References

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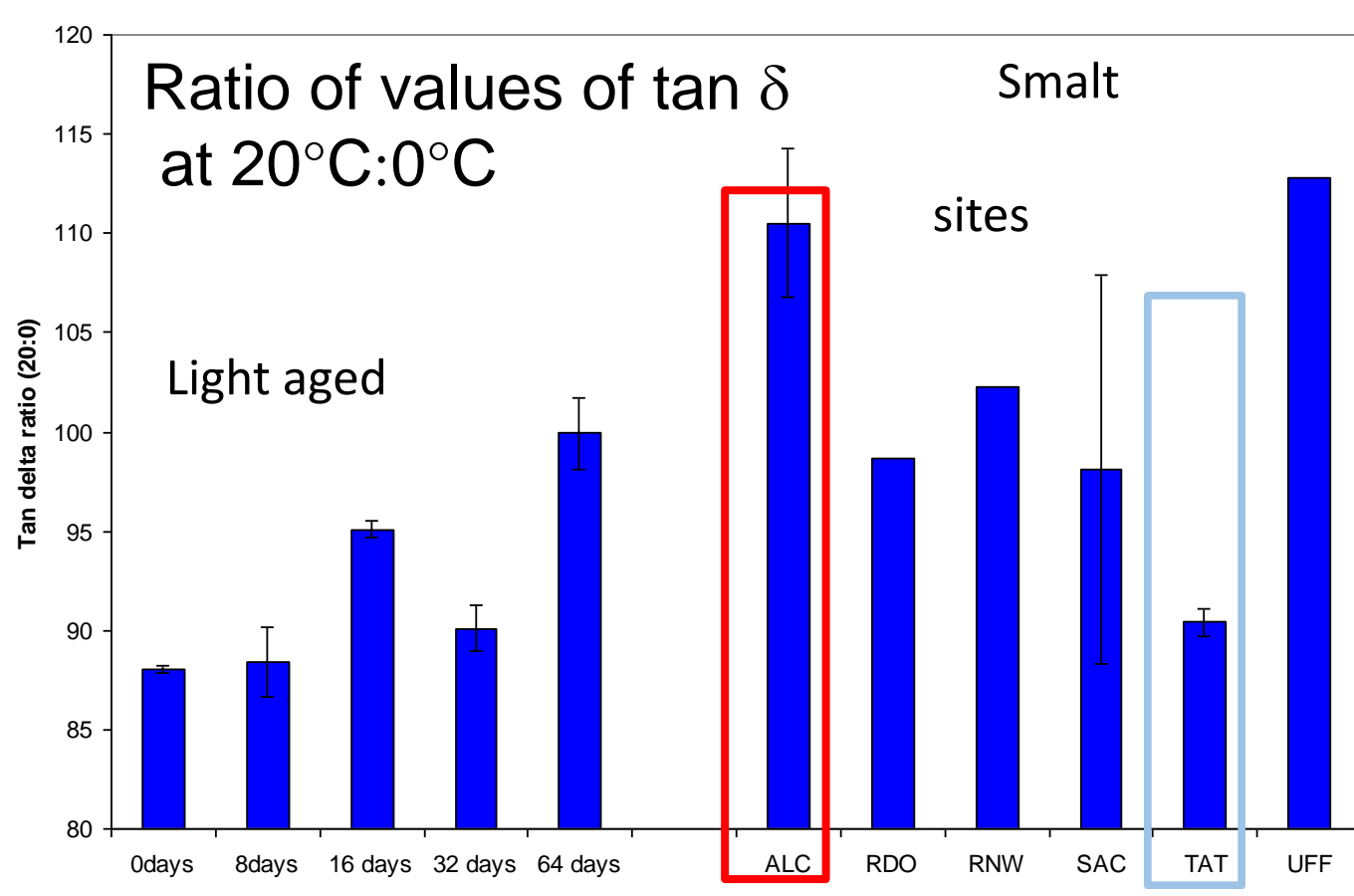
Highlight outcomes of the ERA project

ERA dosimeter results for exposure in the Rijksmuseum RNW after 9 months : higher numbers infer more damaged sample (maxm score 6).

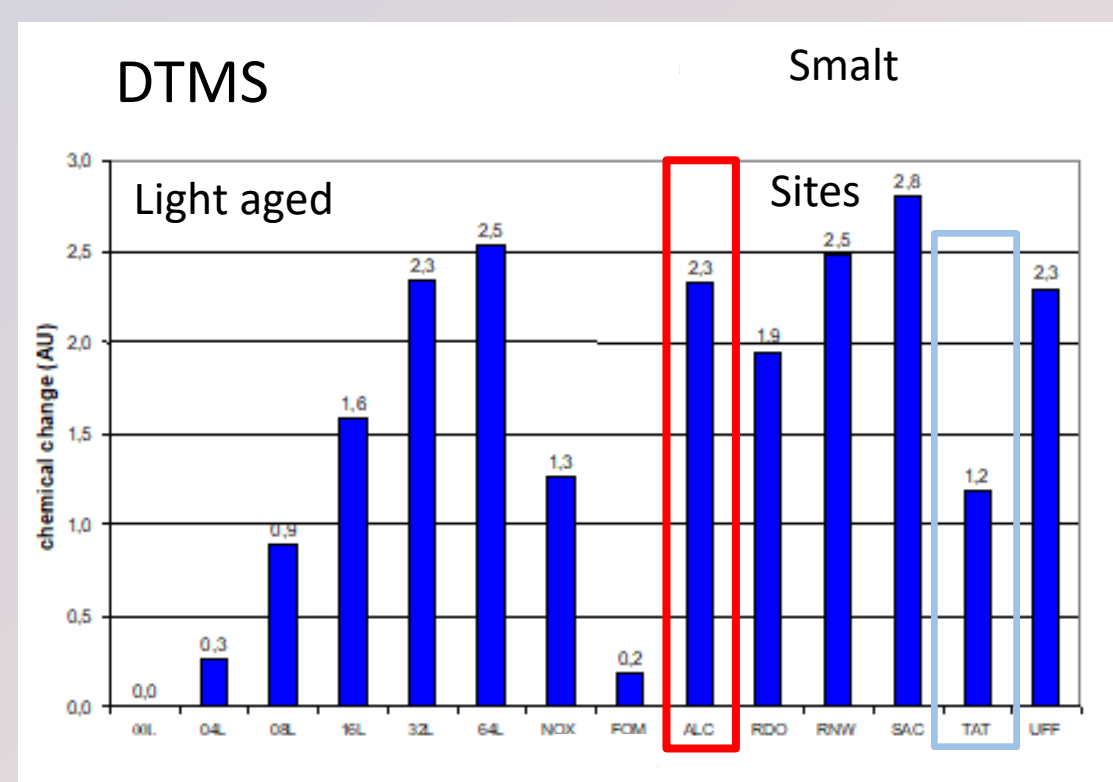
Pigment	PbW	PbNY	Smalt	Azurite	Sienna	No pigment	Alizarin	Curcumin
DTMS	2	2/3	3/4/5	-	4/5	4	4	2
DMA	-	3	3	1/2/3	-	-	-	-
FTIR	3/4/5/6	1	2/3	1/2/3	3	3	-	-
VIS (ΔE)	2/3/4	-	1/2	-	-	-	1/2/3/4/5	1/2/3/4/5



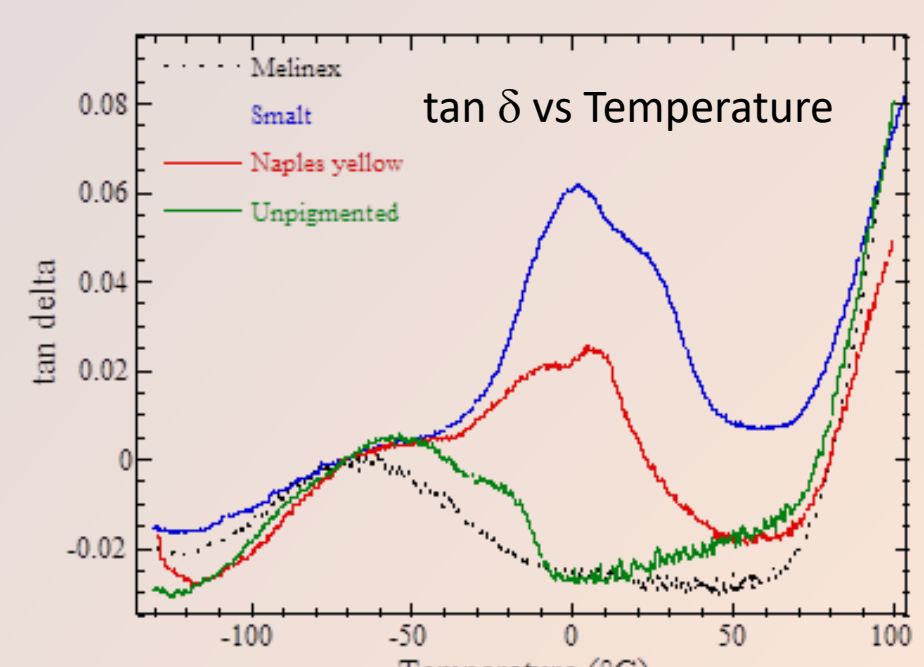
Dynamic Mechanical Analysis (DMA) of smalt tempera at 1Hz



Increase in ratio indicates change in polymeric network and is dependent on chemical change.

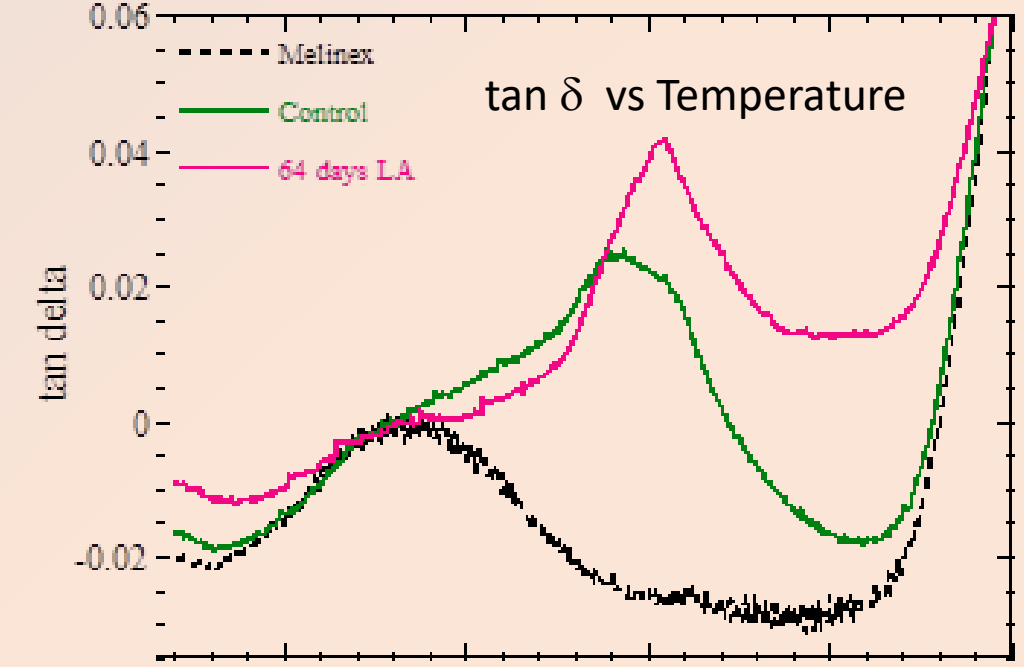


Formation of polymeric network by some pigments



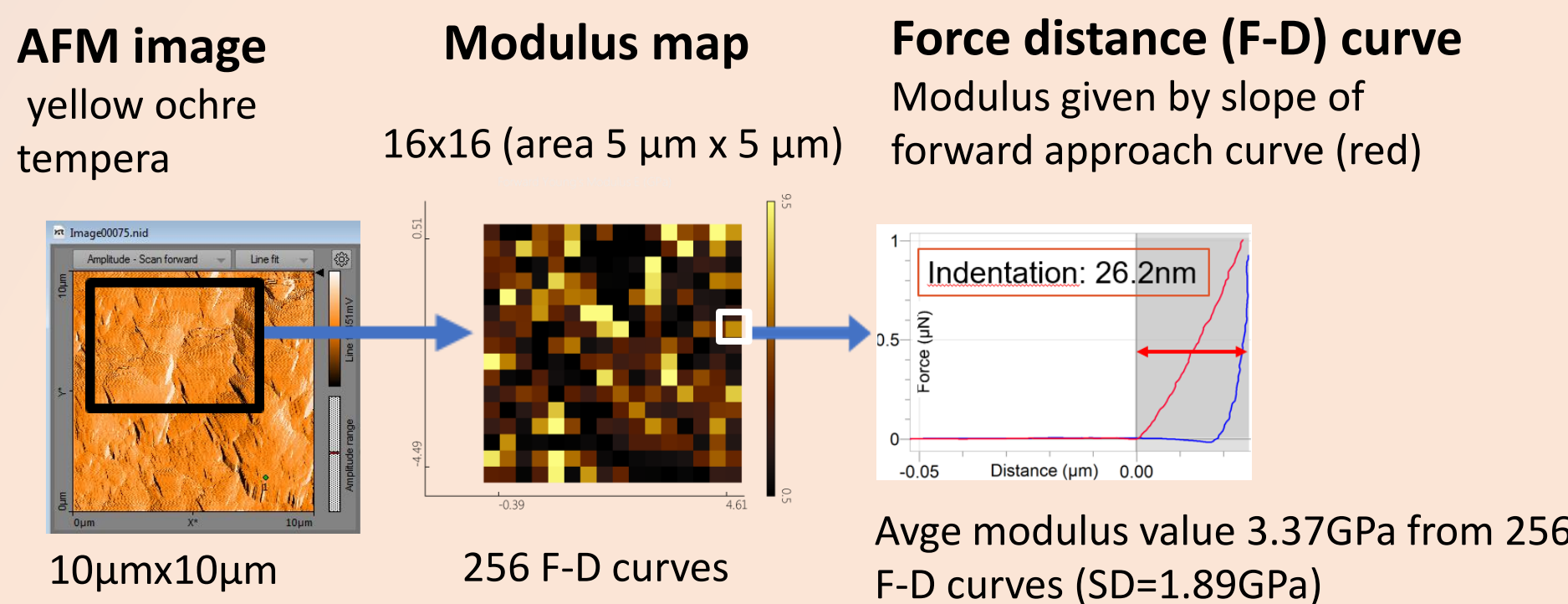
DMA: unpigmented tempera green, red Naples yellow and blue (smalt) 1Hz

Effect of accelerated light ageing on Naples yellow tempera



DMA: Melinex peaks (black dotted line) green control and red 64L Naples yellow (NY) 1Hz

Looking forward : nanomechanical studies on paint tempera



Conclusions

- Results from ERA have demonstrated differences in pigment–binder interactions e.g lead white and azurite.
- Some new correlations between techniques e.g DTMS & DMA can be seen
- DMA data have been used in AKTS Thermokinetics. Difference in ageing profiles and lifetime predictions for smalt and azurite temperas.
- The idea of using paint dosimeters led to work in other projects e.g EU project PROPAINT and investigation of corrosivity of micro-climate frames.
- Current publications^{5,6,7} listed here in references point to strong interest in further understanding chemical changes in tempera paint, also effect of moisture, and changes at the nanoscale.

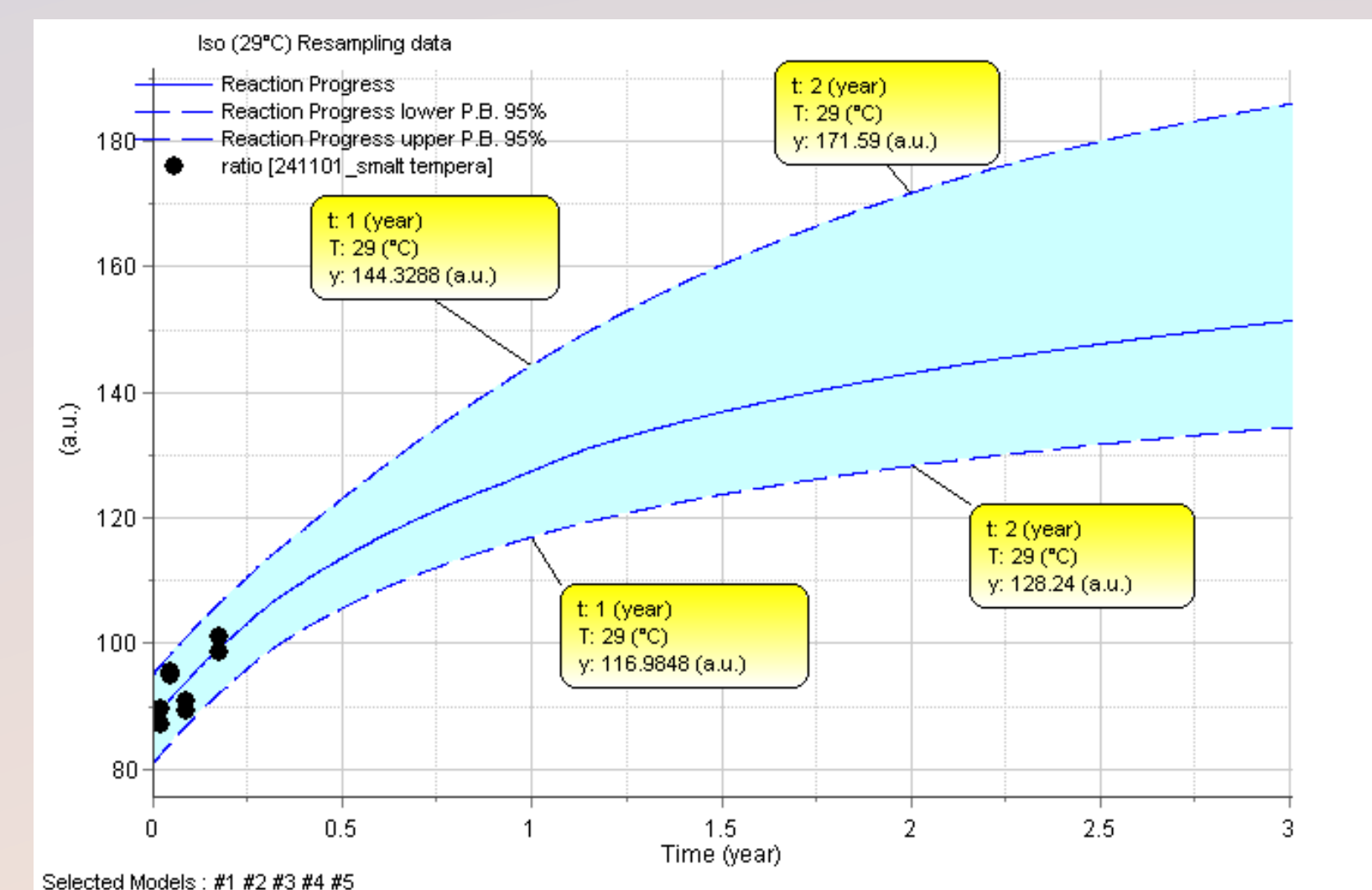
Looking forward: AKTS Thermokinetics software

1. **Accelerated thermal ageing** : At least 20 experimental datapoints collected at different temperatures.

2. Screen kinetic models : perform fitting procedures and rank kinetic models according to statistical analyses

3. **Predict long term stability** and confidence intervals Predictive bands (eg CL95%) obtained by statistical analysis (bootstrap)

Prediction of tan δ values after 1 and 2 years of light ageing of smalt tempera

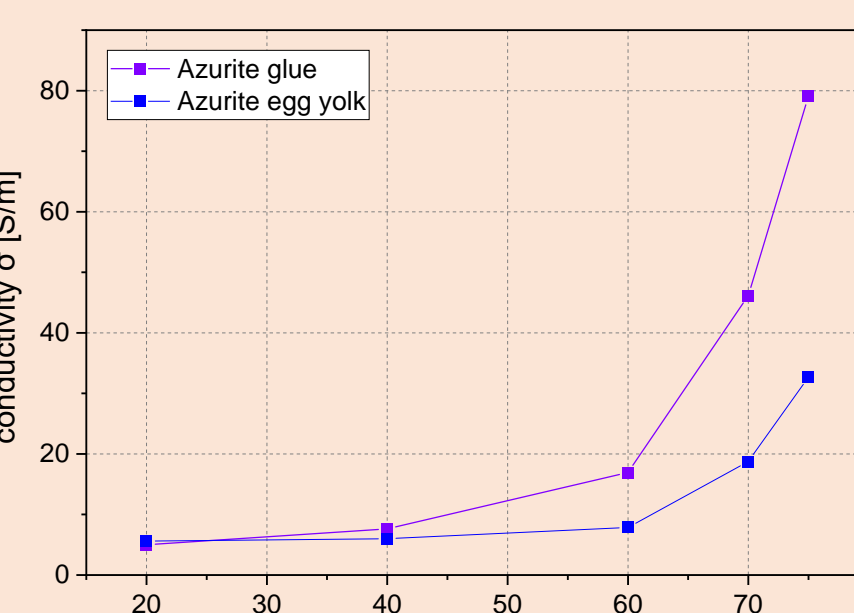


Looking forward : effect of programmed RH on behavior of egg tempera paint

In collaboration with K. Poznańska* Controlled environment Dielectric Analysis measurements to complement DMA –RH data : work in progress

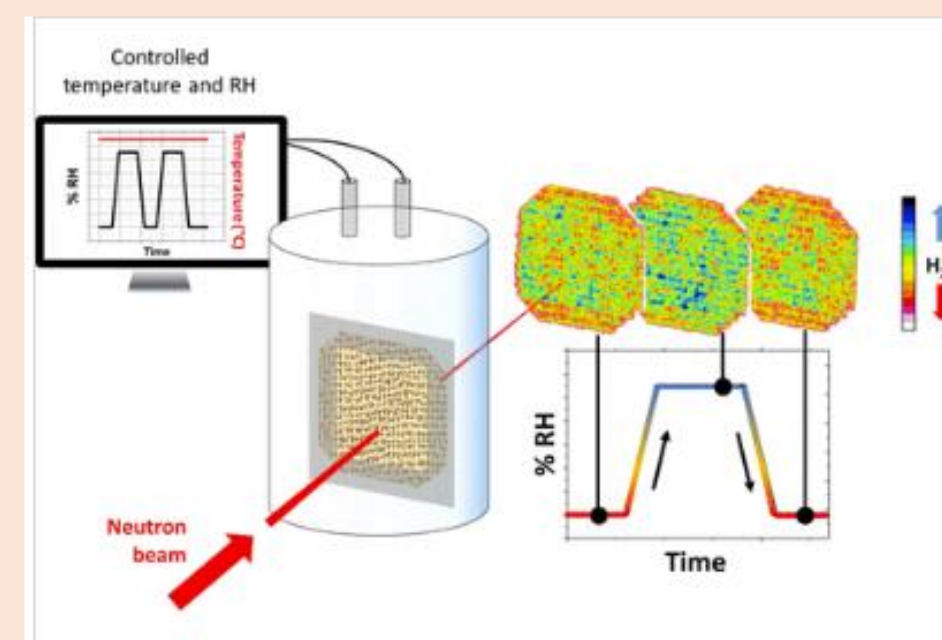
Controlled RH Dielectric Analysis

DETA-RH programmed RH at set temperature



Conductivity vs RH(%) for azurite glue (purple) and azurite egg (blue) samples. Samples and data plot provided by K. Poznańska.

Future work includes Controlled environment Neutron Radiography: plans to test paint tempera samples with experiment set-up used on painting canvases⁸



Acknowledgements

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