

In-situ Damage Assessment of Micro-climates for Cultural Heritage Preservation

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This paper reports on damage dosimeters which have been developed and which can function either as continuous data loggers or as passive samplers interrogated at monthly intervals. The continuous monitoring unit (QTS-3) has been exposed at 3 sites: Charlottenborg Castle, Copenhagen, the Petrie Museum, London, and Osterley Manor, National Trust, England, Wales and Northern Ireland. The resulting data show differences and are expressed in terms of the measured frequency shift (post exposure) relative to the original coated frequency [f (Hz)/ F (kHz)]. Multiple exposures of dosimeters as passive samplers will also be reported and here data are available from exposure at 2 sites in the Alcazar, Segovia, Spain and 2 sites at the National Museum of Denmark, Copenhagen. The basic principle of operation is that of the quartz crystal microbalance [1]. The crystals (also known as piezoelectric quartz crystals [PQC]) are coated with either artists' varnish (resin mastic) or medium (egg tempera). Following exposure to selected environments of varying climatic conditions damage is caused to the layer of varnish or medium applied to the crystals. Dosimeters have been exposed at sites where climatic conditions including pollutants concentrations have been monitored for the periods of dosimeter exposure and from laboratory measurements where dosimeters have been exposed to controlled levels of RH, T and selected pollutant gases. The resulting damage has been evaluated from the chemical changes in the varnish or medium by FTIR, mass spectrometry, X-ray surface analysis, and thermomechanical techniques. The microclimates selected at the sites and which are used for calibration of the dosimeters in terms of natural ageing could then be described both in terms of the climate data and the chemical and crystal data. Climate data collected from sites have been compiled: *Grand Unified MIMIC Data Base "GUMD"* <http://iaq.dk/mimic>. This site is hosted on the web-server of NMD. In the data reduction a record is made of the number of times RH and T values exceed certain limits for calculating risk factors. The light dosage (luxh) and the

pollution dosage($\mu\text{g}/\text{m}^3\text{h}$) are calculated for each PQC exposure period. In addition for some of the sites the Time Weighted Preservation Index is calculated for a 12 month period [2].

[1] K. -T. Lau, J. Micklefield and J. M. Slater, *Sens. Actuators B*, 1998, 50, 69

[2] Reilly, J.M., Nishimura, D.W and Zinn, E., “ New Tools for Preservation” ISBN 1-887334-46-7 (1995)