GLASS TRANSITION IN PLASTIC ART WORK ARTEFACTS

S, Da Ros[1], Isabella Del Gaudio[1], John Duncan[2], Katherine Curran[1]

1. Institute of Sustainable Heritage, The Bartlett School of Environment, Energy and Resources, Central House, 14 Upper Woburn Place, London, WC1H 0NN.

2. Lacerta Technology Limited, 2 Lace Market Square, Nottingham, NG1 1PB.

The advent of plastics in the early 20th century revolutionised society through several life-style and technological applications. The conservation of these early plastics in heritage collections is a challenge however, given the presence of degradation processes which may result in changes in the artefacts properties. Degradation may occur due to undesired chemical reactions, but can also develop from physical processes, such as the loss of plasticiser, leading to the increase of the brittleness of the material and potentially to its mechanical failure.

The glass transition, T_g, is sensitive to changes in the polymer structure, and is therefore a powerful source of information about the degree of degradation. In particular, the development of structural relationships, such as those between the plasticiser content and T_g, can be of fundamental importance for investigating the plasticiser loss effect on degradation rate. Dynamic mechanical analysis (DMA) allows for the determination of the T_g with higher sensitivity in comparison to the traditional differential scanning calorimetry (DSC) analysis, especially when applied to semi-crystalline material with a low amorphous content, such as that seen in cellulose nitrate (CN) based artefacts. In addition, given the high sensitivity of the storage modulus towards changes in molecular mobility, several relaxation processes can be identified in addition to the glass transition. However, different methods are suggested for defining T_g from DMA experimental data, resulting in distinct T_g values. For CN based materials, the use of the tan δ signal should be avoided, since this signal may be influenced by the decomposition start at higher temperatures.

This work evaluates DMA and DSC techniques for determining the T_g of artefacts based on cellulose nitrate material and its derivatives, in order to develop structural relationships between T_g and the article's properties. Samples were analysed in a Tritec 2000 DMA and in a Shimadsu TA60 Heat-Flux DSC system. Fig. 1 (a) shows the derivative of the storage modulus, indicating a T_g at nearly 100 °C for a CN based sample. In contrast, the derivative of the heat flow, Fig.1 (b), did not allow for the T_g discrimination. Further experiments will investigate the plasticiser content and sample ageing effects on T_g.