Effect of Saline on Epoxy Resin Paint Run in Tension Geometry

Summary

The use of the PerkinElmer® DMA 8000 for the analysis of the α (Tg) relaxation of epoxy resin paint samples is demonstrated in this application note. The resin used for these experiments was used as a corrosion inhibiting coating for marine applications. Samples were prepared and run as received, soaked in saline solution for 7 days and totally immersed during the measurement. Comparisons of the Tg as a result of exposure to saline solution is discussed. In addition, secondary peaks observed in the soaked sample are attributed.

Introduction

Dynamic Mechanical Analysis (DMA) is one of the most appropriate methods to investigate relaxation events. The glass transition (Tg) is a key process in any material but is especially important for paint materials. The mechanical properties of paint are dependant on the temperature that the paint is exposed to during its lifetime. For marine applications, the influence of salt water (saline solution) can have an effect on the Tg and this needs to be understood and quantified. Epoxy resin paint can be applied to an inert surface and, once cured, be peeled off to produce a film. In this application note, the paint film is run in tension geometry in the DMA 8000.

The DMA 8000 works by applying an oscillating force to the material and the resultant displacement of the sample is measured. From this, the stiffness can be determined and tan δ can be calculated. Tan δ

Experimental

Temperature scan of epoxy resin film.

The paint was applied in a thin coating to a PTFE sheet and allowed to cure. Once dry, the film was removed and cut for use in the DMA 8000. Three experiments were performed: (a) A sample was run with no pre-treatment in air, (b) A sample was soaked in saline solution for 7 days and run in air in the DMA 8000, (c) A sample was run in the DMA 8000 while immersed in saline solution during the measurement using the fluid bath.

Equipment	Experimental Conditions	
DMA 8000	Sample:	Epoxy Resin Film
Fluid Bath	Geometry:	Tension
Circulator	Dimensions:	5.2 (l) x 5.8 (w) x 0.2 (t) mm
	Temperature:	0 °C to 120 °C at 2 °C min^{-1}
	Frequency:	1 Hz

is the ratio of the loss component to the storage component. By measuring the phase lag in the displacement compared to the applied force it is possible to determine the damping properties of the material. Tan δ is plotted against temperature and glass transition is normally observed as a peak since the material will absorb energy as it passes through the glass transition.

The epoxy paint samples in this experiment were run under normal temperature ramp conditions initially. To investigate the properties of the material while immersed in saline solution, the PerkinElmer Fluid Bath was used to keep the sample immersed during the measurement.

Results and conclusion

In Figure 1, the sample run without any pre-treatment (red line) shows a strong glass transition peak at about 59 °C. The sample run while immersed in saline (blue line) shows a similar response with a small degree of plasticization indicated by a small decrease in the Tg.

The sample which was pre-treated for 7 days in saline then run in air in the DMA (black line) shows a very different response. The Tg value is consistent with the other results indicating very little plasticization of the material. The magnitude of the tan δ is significantly reduced, which might indicate the sample had become more elastic. This is probably not correct as the second peak at around 100 °C is almost certainly due to loss of water from the sample. This infers that the sample composition was changing as it was heated in air which would have an effect on the magnitude of the Tg observed.

These data show the value of making measurements while a sample is immersed in a liquid environment. Without this capability, the only option would be to perform an experiment such as the black line in the graph. This would not have given the information required and may possibly have lead to incorrect conclusions from the data.

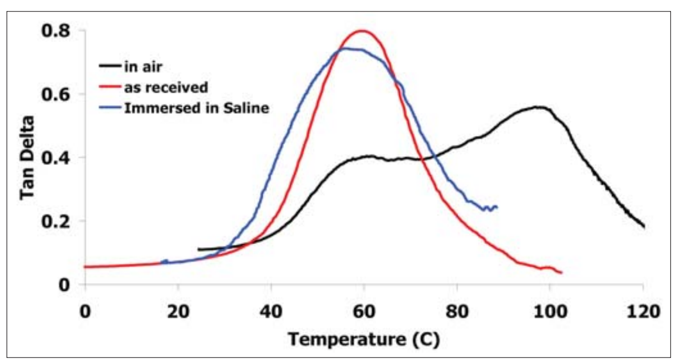

Figure 1. Data results of temperature scan of epoxy resin film.

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