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Creep Lifetime Prediction

Keywords - Creep, Lifetime prediction, Dynamic mechanical analysis

What Was Needed?

A plastic retention clip was required in a commercial appliance. Based upon the application requirements, including impact resistance, polycarbonate appeared to be a good material choice. However, the clip also needed to withstand a continuous loading of 6,400 psi, thus creep failure was a concern. The useful life requirement for the product was stated to be 2 years.

Evaluation

Dynamic mechanical analysis (DMA) was used to evaluate the polycarbonate resin being considered. Initially, a temperature sweep was conducted to characterize the response of the material to temperature (Figure 1). The modulus of the material was relatively stable near 23 °C, the nominal use temperature of the clip.

A series of isothermal DMA scans were performed and the results were combined using time-temperature superposition (TTS) to create a master curve of modulus over time. The response of the material showed an apparent loss in modulus over time with an inflection point (Figure 2).

Tensile testing was conducted on the polycarbonate material to characterize the mechanical properties, and determine the modulus, yield point, and the proportional limit (Figure 3). The tensile data and the apparent modulus master curve were then combined to create a master curve of strain over time (Figure 4). Based upon the obtained results, the material was expected to undergo creep, with cracking projected to initiate after approximately 3.9 years in service.

Conclusion

The creep prediction study showed that the polycarbonate resin had a projected lifetime of 3.9 years under the indicated application conditions, including use at 23 °C under continuous loading at 6,400 psi. This was almost double the 2 year requirement, and so the polycarbonate resin appeared to be a good selection.

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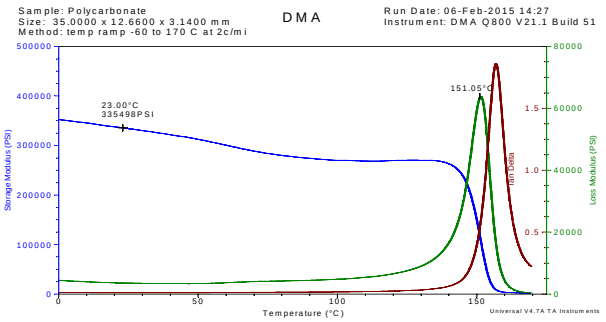

Figure 1: DMA temperature sweep showing the response of modulus to temperature.

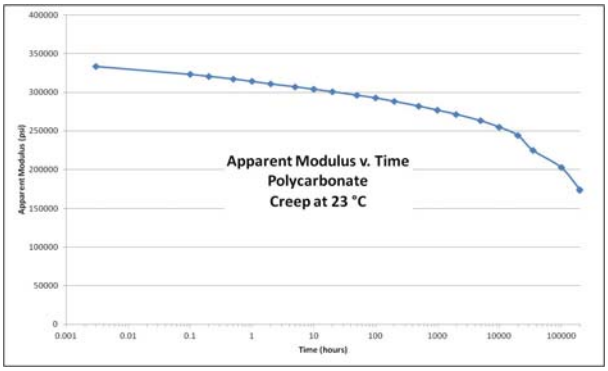

Figure 2: Plot of apparent modulus over time.

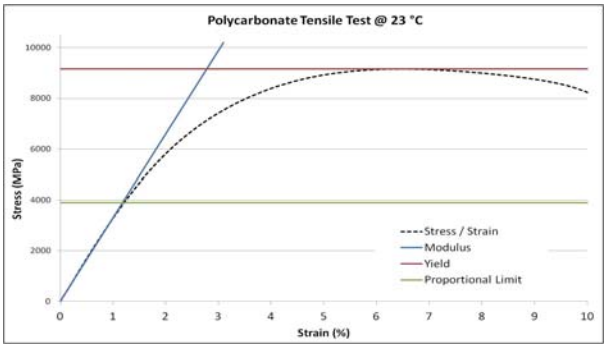

Figure 3: Stress-strain obtained on the polycarbonate resin..

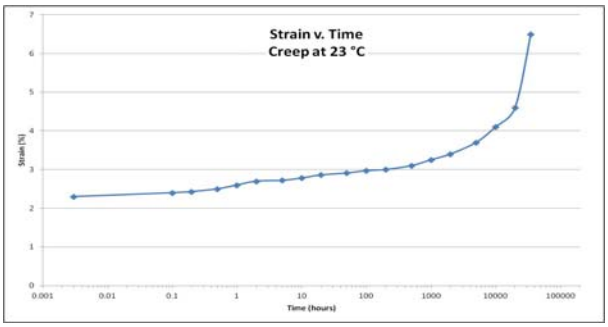

Figure 4: Plot of projected strain versus time.