Predicting the high strain rate response of plasticised poly(vinyl chloride) using a fractional derivative model

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Abstract. Polymers are frequently used in fields as diverse as aerospace, biomedicine, automotive and industrial vibration damping, and are often subjected to high strain rate or impact loading. Poly(vinyl chloride) (PVC), and its plasticised variants (PPVC), are just two examples of this broad category of materials. Since many polymers exhibit strong rate and temperature dependence, including a low temperature brittle transition, it is extremely important to understand their mechanical responses over a wide range of loading conditions. PVC with 60 wt% plasticiser is used in this study, as its highly rubbery nature lends itself well to being used in various load mitigation and energy absorption applications. It is challenging to obtain high strain rate data on rubbery materials using conventional techniques such as the split-Hopkinson (Kolsky) bar. Therefore, alternative approaches are required. Based on previous work developing a framework to predict high rate response using a fractional derivative model [1], Dynamic Mechanical Analysis (DMA) experiments are conducted on the PPVC to construct a master curve of storage and loss moduli. These data are used to calibrate a model which also takes into account specimen heating to derive stress-strain relationships at strain rates varying from 0.001 s^{-1} to 13 500 s^{-1}. This model is validated against experiments conducted at these rates [2].

References

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