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Selecting design-appropriate material descriptions for linear viscoelastic materials

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We describe a process to mathematically model and optimize design targets for linear viscoelastic systems. Our previous work [1] has shown that simple engineering design assumptions can be relaxed from a conventional spring-dashpot topology to a generalized linear viscoelastic relaxation kernel G(t) (though importantly, the viscoelastic moduli G' and G" are not independent design functions). With the relaxation kernel as the design variable, one can identify optimal viscoelastic properties agnostic to any specific material structure or spring-dashpot topology. We extend this work by evaluating different representations of linear viscoelasticity beyond the traditionally used Generalized Maxwell Model, such as simple parameterizations of continuous spectra including the log-normal continuous relaxation spectra. These parameterizations of relaxation spectra are known to be realistic descriptions of achievable materials. This approach provides the opportunity to reduce computational complexity (by dramatically reducing the number of design parameters involved) while confining the designed systems to be realizable materials, aiding in the use of these early-stage design targets for either material-specific selection or later-stage material synthesis and design of materials.

References

[1] Corman, R.E., L. Rao, N.A. Bharadwaj, J.T. Allison, R.H. Ewoldt, "Setting material function design targets for linear viscoelastic materials and structures," Journal of Mechanical Design, 38 (5), 051402 (2016), http://dx.doi.org/10.1115/1.4032698