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Materials with Tunable Behavior due to Constrained Instabilities: Performance and Stability Analysis DENNIS KOCHMANN, California Institute of Technology, WALTER J. DRUGAN, University of Wisconsin-Madison — Combining several materials into a composite permits the creation of new materials with overall properties tunable via a careful choice of the constituent materials with favorable specifics. The probably simplest example is a particle-matrix system, in which particles of one material enhance the mechanical behavior of the matrix material. Recent advances have confirmed that the overall performance of such a composite (e.g., its viscoelastic properties) can be dramatically altered, and stiffness and damping can be tuned to an extreme if one allows for temporarily negative elastic moduli in the inclusion. Such incremental negative moduli imply instability; e.g. a free-standing body of negative stiffness is thermodynamically unstable. However, through its geometric constraint a matrix phase can stabilize the otherwise unstable state of the inclusion phase, thus rendering the overall composite stable. In this contribution, we show, based on dynamic stability analyses, that the matrix constraint does indeed allow for the existence and use of negative moduli, and that this effect can be utilized to design novel composites of superior performance. Approaches to stabilize the negative-stiffness effect will be discussed as well as the performance of such composites.

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