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Dynamics assessment of mechanically induced solid phase transitions in shape memory alloys via nonlocal thermomechanical coupling

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Abstract: The work deals with presentation of the properties and applications of the developed nonlocal model of shape memory alloys (SMA), which is dedicated for simulations of dynamic processes of mechanically induced solid phase transitions. To date, many various phenomenological, macroscopic, microscopic and the free energy based constitutive models have been proposed for SMA, however, none of them is able to reliable capture the complexity of SMA physical behavior in a comprehensive manner. The authors of the present work employ peridynamics to alternatively nonlocally formulate thermomechanical coupling in the modeled SMA, considering, therefore, its advantageous characteristics. Particularly, the phenomenon of superelasticity is investigated and the related phase transitions in SMA are studied. The elaborated peridynamic model of SMA is validated using the experimental data gathered with a fatigue testing machine and a high-speed infrared camera. With reference to the authors' recently published work, the newly proposed solution extends the functionalities of the former nonlocal SMA model, taking into account the influence of the temperature. As confirmed with the numerical results provided, the new capability allows for studying dynamic problems more conveniently, not being limited by the necessity of satisfying the condition of isothermal phase transition. This study was funded by National Science Center, Poland (Grant No. OPUS 2017/27/B/ST8/01822 Mechanisms of stability loss in high-speed foil bearings — modeling and experimental validation of thermomechanical couplings).

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