ABSTRACT

The main goal of this thesis research is to expand the range of unique properties of phase transforming cellular materials (PXCMs), a new class of architected materials, and to extend their applicability both in the engineering disciplines and in the medical field. A novel aspect of PXCMs is their unique energy dissipation during loading via a snapping mechanism associated with a geometric transition between one stable configuration to another stable configuration at the unit cell level. Phase transformation is analogous to displacive transformations, such as martensitic transformations in shape memory alloys, with no change in configurational entropy. To accomplish this goal, three problem areas are addressed with the first exploring the effects of length scale as added structural hierarchy on material properties and energy dissipation, the second providing an analysis of the durability of architected materials via a novel additive manufacturing method, and the third, an extension into the medical field. Two examples are provided that demonstrate the effects of length scale as added structural hierarchy on material properties, and a machine learning approach for the feasible design of materials with additional levels of structural hierarchy is presented. A simple design approach coupled with a novel additive manufacturing method is discussed for the design of architected materials with high durability. Lastly, a concept for de-clogging bile stents via a temperature driven, shape-memory mechanism inspired by peristaltic locomotion in the human esophagus is presented.

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