Architected materials: Performance through deformation

Abstract: Although the study of the effect of shape and geometry on the mechanical response of solid objects has a long history, the surge of modern techniques to fabricate structures of complex form paired with our ability to simulate and better understand their response has created new opportunities for the design of architected materials with novel functionalities (also referred to as metamaterials). Since the properties of architected materials are primarily governed by the geometry of the structure (as opposed to constitutive ingredients at the material level), we show that deformation and instabilities, which significantly alter their initial geometry, can be harnessed to achieve new modes of functionality. Here, we focus on two different classes of such structures: systems built using elastic bi-stable beams and reconfigurable prismatic architected materials comprising a 3D network of plates and hinges. Altogether, these studies can inform simplified routes for the design of tunable architected materials over a wide range of length scales.

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Katia Bertoldi is John L. Loeb Associate Professor of the Natural Sciences at the Harvard John A. Paulson School of Engineering and Applied Sciences. She earned master degrees from Trento University (Italy) in 2002 and from Chalmers University of Technology (Sweden) in 2003, majoring in Structural Engineering Mechanics. Upon earning a Ph.D. degree in Mechanics of Materials and Structures from Trento University, in 2006, Katia joined as a PostDoc the group of Mary Boyce at MIT. In 2008 she moved to the University of Twente (the Netherlands) where she was an Assistant Professor in the faculty of Engineering Technology. In January 2010 Katia joined the School of Engineering and Applied Sciences at Harvard University and established a group studying the mechanics of materials and structures. She is the recipient of the NSF Career Award 2011 and of the ASME’s 2014 Hughes Young Investigator Award. Dr Bertoldi’s research contributes to the design of materials with a carefully designed meso-structure that leads to novel effective behavior at the macroscale. She investigates both mechanical and acoustic properties of such structured materials, with a particular focus on harnessing instabilities and strong geometric non-linearities to generate new modes of functionality. Since the properties of the designed architected materials are primarily governed by the geometry of the structure (as opposed to constitutive ingredients at the material level), the principles she discovers are universal and can be applied to systems over a wide range of length scales.