Multi-functional representation of a novel NiTi-based compression-induced-twisting structure manufactured by selective laser melting

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Compression-induced-twisting (CIT) structure, as a kind of new conceptual metamaterials, recently has got great attention and presented a huge potential in aerospace engineering, smart actuators and propellers, smart flexible microelectronics as well as biomechanical devices, due to a programmable twist behavior under compression. In this work, we designed a kind of novel NiTi-based CIT structure based on the freedom and constraint topology method. Selective laser melting (SLM) 3D printing technology was used to manufacture this CIT structure. An ideal linear relationship between twisting angle and axial strain was established based on three-dimensional finite element mechanical model. In consideration of the choose of NiTi alloys with thermoelastic martensite phase transformation, the twisting behavior of this CIT structure could be controlled by multi physical variables including strain and heat. Additionally, we also performed the cyclic compression tests at a temperature more than martensite-austenite finish temperature (A_f), to evaluate the stability of the mechanical behavior. Besides, considering the service environment for aerospace application, thermal conductivity property of this CIT structure was further assessed in order to characterize the heat-shielding performance.