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Sandra Herzig

Wissenschaftlicher Mitarbeiter

Fraunhofer Institut für Werkzeugmaschinen und Umformtechnik IWU

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Additive manufacturing of programmable materials with NiTi

Shape memory alloys can change in a controlled way in response to an externally applied stimulus in regard to shape and can be utilized in applications in which a specific functionality is required. Additive manufacturing of shape memory alloys is used to achieve unique properties, which cannot be realized by conventional manufacturing techniques. Processing NiTi with laser powder bed fusion (LPBF), enables the fabrication of complex 3D structures with specifically designed material behaviour that follow logic descriptions.
In this contribution, we will present the additive manufacturing of NiTi lattice structures with programmable mechanical behaviour in the as-built condition. The results show the potential of manufacturing uniform and filigree NiTi structures on conventional LPBF-machines including bend, inclined struts with strut diameters of 200 µm. The phase transformation temperatures and therefor the transformation stress levels as well as the quality of the structure can be adjusted by means of the selected laser parameters and scan strategy. As a result of the chosen unit cell design and the pseudoelasticity of NiTi, the metallic structure exhibits a distinct change in stiffness under compression load and elongations of over 20 % without failure. Manufacturing pseudoelastic NiTi with reversible cyclic deformation accomplishes the ability of exploiting the programmable behaviour for many cycles. The results show the potential for further investigations of LPBF-produced NiTi and the manufacturing and characterization of NiTi with programmable behaviour.

1 Fraunhofer Institute for Machine Tools and Forming Technology IWU, Dresden, Germany
2 Technical University of Dresden, Dresden, Germany