Deformation-Induced Martensitic Transformation In Fused Filament Fabricated Austenitic Stainless Steels During Tension At Wide Range Of Temperatures. Part 2: Numerical Simulation

D. Schob[1], J. Tabin[2] , J. Kawałko[3], Ph.Maasch[1], R. Roszak[1,4], L. Richter[1], Z. Kowalewski[2] and M. Ziegenhorn[1]

[1]Brandenburg University of Technology Cottbus-Senftenberg, Senftenberg, Germany,
e-mail: daniela.schob@b-tu.de
[2]Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland
[3]AGH University of Krakow, Krakow, Poland
[4]Poznan University of Technology, Poznan, Poland

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ABSTRACT

Structural components of superconducting magnets (e.g., collars, bladders, or keys) with complex shapes, operating at cryogenic temperatures (4K, 77K), as well as additional elements of tanks for storing liquid hydrogen (20K), such as hoses and valves, are made of austenitic steel. With conventional manufacturing technologies, complex geometries are difficult to manufacture. In contrast, additive manufacturing offers the possibility of easier production of complex geometries, although the knowledge about the material behavior is not yet comprehensively available. The scientific objective of the project is the experimental identification and numerical simulation of the evolution of the deformation-induced martensitic transformation and the prediction of the material behavior of Fused Filemant Fabricated (FFF) 316L for cryogenic applications.

The material behavior of FFF-316L under tensile stress at both room temperature and 77K was characterized. Utilizing experimental data and microstructure analysis through scanning electron microscopy, a comprehensive material model [1] was used. This constitutive model is centered on the deformation-induced martensitic transformation at both ambient and cryogenic temperatures. The linear kinetic law of evolution of deformation-induced phase transformation in ASS is adopted [1]. It posits that the phase transformation is driven by the accumulated plastic strain. The model intricately links the intensity of plastic deformation to the phase transformation, employing a mixed kinematic/isotropic linear plastic hardening approach based on Mori-Tanaka homogenization. A numerical results will be verified experimentaly at room and at 77K.

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