Microstructure and texture evolution of Ni-Mn-Ga magnetic shape memory alloys produced by Laser Powder Bed Fusion

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Abstract

The Laser Powder Bed Fusion (LPBF) process was used to manufacture NiMnGa-based polycrystalline samples. The initial powders with a fine particle size of about 20 μm were firstly prepared by ball milling process from melt-spun ribbons. Two different strategies were used. The first one produced bulk materials and the latter one scaffolds with controlled porosity. The microstructure and texture evolution of the printed NiMnGa alloys were investigated using SEM, TEM, and synchrotron radiation diffraction. Moreover, employing two different scanning modes, optimization of laser parameters and post-processing heat treatment, a homogeneous microstructure with a strong crystallographic texture was obtained. The specific conditions produce a layered microstructure with a strong fiber texture along the growth direction. Changing the scanning mode altered the texture toward the double fiber orientation. Mechanical training changes the texture drastically showing that the so-called orthogonal shear process initiates variant reorientation leading to the replacement of the main with conjugated twin boundaries. The results are discussed with respect to scanning strategy, crystal structure, twinning stress, and resulting magnetic field-induced strain.

Keywords: Ni, Mn, Ga Heusler alloys, MFIS, LPBF, texture, TEM

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