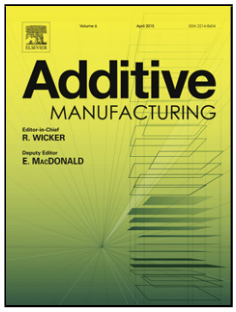

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4D Printing of Net Shape Parts Made from Ni-Mn-Ga Magnetic Shape Memory Alloys

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Abstract

This work investigates an additive manufacturing route of producing functional net shaped parts from pre-alloyed magnetic shape memory Ni-Mn-Ga powders. Three types of Ni-Mn-Ga powders were used in this investigation: spark eroded in liquid nitrogen (LN_2), spark eroded in liquid argon (LAr), and ball milled (BM). Additive manufacturing via powder bed binder jetting, also known as 3D printing (3DP) was used in this research, due to both relatively easy control of part porosity and the possibility to obtain complex shaped parts from Ni-Mn-Ga alloys. Porosity plays an important role in increasing magnetic field induced strains (MFISs) in polycrystalline Ni-Mn-Ga by reducing the effect of constraints imposed by grain boundaries, thus enabling twin boundary motion. On the other hand, conventional shaping and forming cannot be performed on bulk Ni-Mn-Ga magnetic shape memory alloy (MSMA), due to its limited ductility. Binder jetting of Ni-Mn-Ga powders followed by curing and sintering proved successful in producing net shaped porous structures (spring-like, 3-D hierarchical lattice structures, etc.) with good mechanical strength. Parts with porosities between 24.08% and 73.43% have been obtained by using powders