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Abstract

The paper presents a new approach to selective laser melting (SLM) of alloys with low glass-forming ability and the basics of microstructure evolution during SLM of iron-based metallic glasses. After extensive parameters optimization, a novel scanning strategy, involving two-step melting, comprising preliminary laser melting, followed by short-pulse amorphization, has been introduced to maximize the glassy phase fraction and ensure good magnetic properties. Single melted samples show poor amorphisation with well separated amorphous regions and coercivity of 1032A/m. Second melting increased the glassy phase content by over an order of magnitude - up to 89.6 % *and reduced coercive force over four-times to 238A/m . X-ray diffractions show significant difference between, arising from melt, disordered Fe(Si) phase and devitrified, ordered Fe_3Si. Coexistence of those phases has been shown in heat affected zone by electron diffraction. Beneficial effect of the novel remelting strategy has been explained on the basis of restricted crystallization in heat-affected zone and reduction of sample overheating, by application of the Point-Random strategy.*

Keywords: metallic glasses, additive manufacturing, selective laser melting, soft magnetic materials.

1. Introduction

Metallic Glasses (MGs) are nonequilibrium materials retaining amorphous structure during cooling from melt. To ensure high cooling rates necessary for amorphization, MGs are typically produced in the form of a ribbon or powder, while vast majority of mechanical and functional applications require materials in a bulk form. In the case of MGs, this is usually obtained by tailoring the chemical composition to lower the critical cooling rate (Bulk Metallic Glasses) or through various powder metallurgy methods [1–6].

Due to exceptional mechanical and chemical properties, MGs and their composites are promising structural [7] bio-, [8,9] and functional materials [10], but high costs of advanced molding systems and a number of technical difficulties still limit their applications.

A new MGs synthesis technique involves an additive process, where the final product is