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Selective laser melting of stainless-steel/nano-hydroxyapatite composites for medical applications: microstructure, element distribution, crack and mechanical properties

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Abstract: This paper presents a study on the layer-by-layer synthesis of stainless-steel (SS) and nano-hydroxyapatite (nHA) composite using selective laser melting (SLM). The microstructural and elemental examinations, tensile and nanoindentation tests were conducted. The effects of material ratios and laser scanning speeds on cracks and pores were identified by the cross-section morphology of samples fabricated by SLM. High content of nHA resulted in the particle aggregation at the melt pool boundaries and the cracks on these areas. Increasing in laser scanning speed shortened the solidification time of melt pools, thus withstood aggregation of nHA and decreased the degree of cracks. Optimum material ratio and laser scanning speed were determined for SLM of SS/nHA composite in order to fabricate load-bearing bone implants. A uniform distribution of Ca and P elements was detected on the top surfaces of as-SLM fabricated composite, which could facilitate good bone osseointegration. The highest tensile strength, elastic modulus and hardness of SS/nHA samples produced at optimum processing condition were found to be higher than that of the human bone, which provides the possibility to fabricate SS/nHA porous scaffolds with tailored mechanical properties for load-bearing bone applications.

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