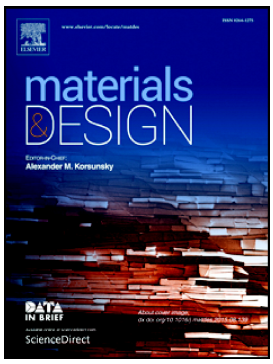

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Anisotropy and heterogeneity of microstructure and mechanical properties in metal additive manufacturing: a critical review

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Abstract

Metal additive manufacturing (AM) has developed rapidly over the last decade to become a disruptive technology capable of revolutionizing the way that products from various industrial sectors such as biomedical, aerospace, automotive, marine and offshore are designed. Early adopters of the technology like the biomedical and aerospace industries have shown that the better-designed components offer substantial performance improvements over current designs. However, in-depth and comprehensive views on the microstructure and mechanical properties of additively manufactured metals and alloys are less reported. To realize the full design potential that metal AM can offer, especially for load-bearing structural components, it is imperative to provide a thorough understanding on the anisotropic and heterogeneous microstructure and mechanical properties that often occur within metal AM parts. This paper outlines a broad range of metal AM technologies and reviews literatures on the anisotropy and heterogeneity of microstructure and mechanical properties for metal AM parts. It can be highlighted that the contributing factors to the anisotropy and heterogeneity within metal AM parts were either their unique microstructural features or manufacturing deficiencies. Concluding remarks on the state-of-the-art research regarding this topic and the possible solutions to overcome the anisotropy and heterogeneity of metal AM parts are provided.

1. Introduction

Metal additive manufacturing (AM), popularly known as metal three-dimensional (3D) printing, is a process of joining metallic materials (in powder, wire, sheet forms, etc.) to make