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A current state of metal additive manufacturing methods: A review

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Abstract

Alloys such as super alloys, Aluminium, titanium alloys are employed for metal additive manufacturing significantly. These alloys are used to make aircraft components, gas turbines and other structural areas. Additive manufacturing (AM), is also known as direct digital manufacturing methods, has improved the mechanical properties of additively manufactured metals. This paper overviews about various metal additive manufacturing methods on recent development and impact of process factors on mechanical behaviour, microstructures, formation of voids, surface status and appearance with respect to various additively manufactured metal alloys. In addition, this article reviewed about the printing challenges pertaining to cracks and void formation, behaviour of material, merits and limitations and layer by layer printed material appearance. Overall, this article gives an overview of metal additive manufacturing, including its benefits and limitations as a criterion for further research in additive manufacturing.

Introduction

Metal Additive manufacturing techniques is employed to manufacture the complex geometries product from 3D CAD model data. The metal powders are applied as successive layers of materials until it becomes a final product. Process parameters of the additive manufacturing include layer thickness, scan speed, hatch spacing, size of the powder particles and orientation of the layer. This AM technique is being used in various industries like biomedical and aircraft industries as this AM technique posses benefits like minimum of waste and flexibility in the design of complex shape. 3D printing of new/novel metals is being developed and need to investigate the impact process factors of 3D printed novel metals. Additive manufacturing adequately changed old manufacturing technique and it has gained great potential to fabricate the metal parts with good integrity and AM seems to be a powerful tool to minimize the complexity and able to make tailor-made products [1].Type of AM method, process parameters and metal powder sizes will impact/affect on material behaviours, mechanical properties, void formation, surface finish and appearance. Therefore, the impact of these parameters needs to be investigated. The manufacturing industries have an agreement to transform the traditional manufacturing techniques to additive manufacturing technology as this technology is imputed to many merits such as manufacturing of complex parts with good accuracy with low cost and adaptable to wide variety of materials. A variety of materials are used nowadays in additive manufacturing including aluminium, titanium, nickel based alloys, polymers, ceramics [2]. Especially, additive technique is prominent in making mass customisation products and AM technique does not require any mould and tool, whereas the conventional methods

require mould and tool and also more time consume. However, AM finds more advantages, the fabrication attributes such as material behavior, printed material structure, and mechanical properties are all need to be improved/optimized. These fabrication attributes are all significantly affected by the type of AM techniques and their controlling parameters like speed, metal powder particle sizes, hatching direction etc. Hence, this article aims to narrate exhaustive review about AM methods to fabricate metal parts with respect to different alloy metals. Further, the research gaps in analyzing the impact of AM technique's parameters are reviewed.

Section snippets

Additive manufacturing methods

AM methods are widely used in many industries especially in automobile industries, aerospace industries and bio-medical industries to make mass customization products at fine accuracy. The AM technique is superior to tradition manufacturing owing to cost, speed, quality, transformation and impact. Moreover, this AM methods are widely applied for Rapid Prototyping, production of spare Parts, small volume manufacturing, customized unique Items, very complex work pieces, machine tool…

Conclusions

- In this review article, the latest Additive Manufacturing techniques for metals and alloys were reviewed with respect to microstructure, mechanical properties, and fatigue life. Additive methods such as Wire arc welding AM, Gas metal arc AM, Lased bed fusion AM, electrochemical additive manufacturing, selective laser melting, electron beam melting and cold spray in additive manufacturing were presented.…
- Researchers have overcome lot of troubles and found much advancement in Additive…

…

Scope of the future work

This review pointed out the potential of additive manufacturing which is one of the effective method to produce complex geometries. Further research can be focused on the followings:

- Still production quality and performance factors, such as dimensional accuracy, strength of parts, and surface roughness, which may need to be improved depending on the complexity and product requirements.…
- Additive manufacturing of difficult to cut materials is found to be less and influence of additive manufacturing …

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CRediT authorship contribution statement

P. Durai Murugan: Writing – original draft, Supervision, Validation. **S. Vijayananth:** Writing – original draft, Supervision, Validation. **M.P. Natarajan:** Writing – original draft, Supervision, Validation. **D. Jayabalakrishnan:** Writing – original draft, Supervision, Validation. **K. Arul:** Methodology, Formal analysis, Writing – review & editing. **V. Jayaseelan:** Methodology, Formal analysis, Writing – review & editing. **J. Elanchezhian:** Formal analysis, Writing – review & editing.…

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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