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**Additive manufacturing - Design - Functionally graded additive
manufacturing**

增材制造 设计 功能梯度增材制造

(English Translation)

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Foreword

This document is a report-type guidance technical document.

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part 1: Structure and Drafting Rules of Standardization Documents". Drafting.

This document is modified to adopt ISO /ASTM TR52912:2020 "Additive manufacturing design - Functional graded additive manufacturing".

This document has undergone the following structural adjustments compared to ISO /ASTM TR52912:2020.

---Added 6.7;

---7.4.2.1 corresponds to the first paragraph of 7.4.2 in ISO /ASTM TR52912:2020;

---7.4.2.2 corresponds to 7.4.2.1 in ISO /ASTM TR52912:2020;

---7.4.2.3 corresponds to 7.4.2.2 in ISO /ASTM TR52912:2020;

---7.4.2.4 corresponds to 7.4.2.3 in ISO /ASTM TR52912:2020. The following editorial changes have been made to this document.

---Move the section on the purpose and significance of this document from the "Scope" chapter to the introduction;

---Added abbreviations for material extrusion, metal laser-directed energy deposition, metal electron beam powder bed melting, and thin-film stacking. (See Chapter 4);

--- The column numbering has been changed (see 6.2);

---Added an introduction to stereolithography functional graded additive manufacturing (see 6.7);

---ISO /ASTM 52900 has been replaced with GB/T 35351 (see 5.1, 6.3) for informational reference;

---The explanation of the origins of abbreviations in Chapter 4 of ISO /ASTM TR52912:2020 has been removed;

---The description of FGAM in reference [56] and reference [18] in section 5.1 of ISO /ASTM TR52912:2020 have been removed. Description of the simulation;

---The source information for the schematic diagrams in sections 5.3 and 6.4 of ISO /ASTM TR52912:2020 has been removed;

---The description of material extrusion and references in reference [32] in section 6.3 of ISO /ASTM TR52912:2020 have been removed. [54] Introduction to material extrusion systems;

---The references [23] and [14] in section 6.5 of ISO /ASTM TR52912:2020 regarding LMD capability have been removed. introduce;

---The description of the FGAM shared portal in section 7.2.1 of ISO /ASTM TR52912:2020 has been removed to comply with existing technical standards. Current status of technology development;

---The CAE software examples in sections 7.2.3 and 7.4.2.2 of ISO /ASTM TR52912:2020 have been removed;

---The description of a certain brand's series of equipment in section 7.3 of ISO /ASTM TR52912:2020 has been removed;

---The description of the limitations of additive manufacturing in reference [56] in section 7.3 of ISO /ASTM TR52912:2020 has been removed;

---The historical background of FAV and 3MF in sections 7.4.2.3 and 7.4.2.4 of ISO /ASTM TR52912:2020 has been removed;

---The ISO /ASTM 52915 standard (see 7.4.2.2) has been replaced with GB/T 35352, which is cited in the informational reference.

Introduction

Additive manufacturing (AM) is a technology that uses three-dimensional model data as a basis to manufacture parts or physical objects by depositing materials. With... Advances in AM hardware and software technology, along with the demands for greater flexibility and efficiency from new market expansion, have led to a higher functional tier.

The research on the design and manufacturing technology of novel materials is gradually gaining attention. This technology is known as Functionally Graded Additive Manufacturing (FGAM), which is a... Layer-by-layer manufacturing technology that achieves the desired function and performance by controlling the distribution of material components within the component.

The concept of functionally graded materials (FGMs) was proposed in 1984, initially to improve heat resistance in order to overcome the shortcomings of traditional composite materials.

Traditional composite materials [Figure 1a)] are homogeneous mixtures, making it difficult to achieve optimal performance. Compared to traditional materials, FGMs are a class of advanced materials.

By controlling the distribution of components in a spatial dimension, the properties of materials can be optimized [56]. FGMs are a type of material that optimizes the properties of materials by controlling the distribution of two or more components in a spatial dimension.

The material composition changes continuously or discontinuously from one orientation [one-dimensional (1D), two-dimensional (2D), or three-dimensional (3D)] to another orientation, thus affecting its properties. Heterogeneous materials that can exhibit gradient changes [Fig. 1b).

Traditional manufacturing processes struggle to produce functionally graded materials with continuous gradients and integrated material-structure relationships. Additive manufacturing processes offer advantages such as... The layer-by-layer deposition of materials is an effective manufacturing method for realizing such functionally graded materials, thus giving rise to functionally graded additive manufacturing.

The concept of FGAM. FGAM is an emerging field driven by academic research and has not yet been standardized; therefore, different terms are used in the literature, for example... For example, Functionally Graded Rapid Prototyping (FGRP)[56], Variable Performance Rapid Prototyping (VPRP)[57], and Performance Localization Additive Manufacturing[72], this document only This description of the current state of FGAM technology is based on existing literature, using the terminology related to FGAM from the original literature, without labeling any terms. Standardization is a purely informational and guiding technical document.

1 Scope

This document describes the concept of functional graded additive manufacturing, and introduces the current state of the technology, its limitations, and potential application areas.

This document applies to the design of functionally graded additive manufacturing.

2 Normative references

This document has no normative references.

3 Terms and Definitions

This document does not contain any terms or definitions that need to be defined.