NSAI Standards

Irish Standard Recommendation
S.R. CEN/TR/ISO/ASTM 52912:2020&ISO-ASTM 52912:2020

Additive manufacturing - Design - Functionally graded additive manufacturing (ISO/ASTM/TR 52912:2020)

S.R. CEN/TR/ISO/ASTM 52912:2020&ISO-ASTM 52912:2020

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National Foreword

S.R. CEN/TR/ISO/ASTM 52912:2020&ISO-ASTM 52912:2020 is the adopted Irish version of the European Document CEN/TR/ISO/ASTM 52912:2020, Additive manufacturing - Design - Functionally graded additive manufacturing (ISO/ASTM/TR 52912:2020)

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TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR/ISO/ASTM 52912

October 2020

ICS 25.030

English Version

Additive manufacturing - Design - Functionally graded additive manufacturing (ISO/ASTM/TR 52912:2020)

Fabrication additive - Conception - Fabrication additive à gradient fonctionnel (ISO/ASTM/TR 52912:2020)

Technischer Bericht für die Gestaltung von additiv gefertigten, gradierten Bauteilen (ISO/ASTM/TR 52912:2020)

This Technical Report was approved by CEN on 31 August 2020. It has been drawn up by the Technical Committee CEN/TC 438.

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European foreword

This document (CEN/TR/ISO/ASTM 52912:2020) has been prepared by Technical Committee ISO/TC 261 "Additive manufacturing" in collaboration with Technical Committee CEN/TC 438 “Additive Manufacturing” the secretariat of which is held by AFNOR.

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TECHNICAL REPORT

ISO/ASTM TR 52912

First edition
2020-09

Additive manufacturing — Design — Functionally graded additive manufacturing

Fabrication additive — Conception — Fabrication additive à gradient fonctionnel

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Foreword

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

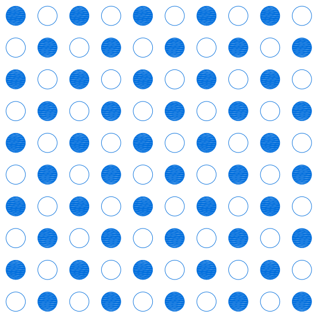
This document was prepared by ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM F 42, *Additive manufacturing technologies*, on the basis of a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on additive manufacturing and in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 438, *Additive manufacturing*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

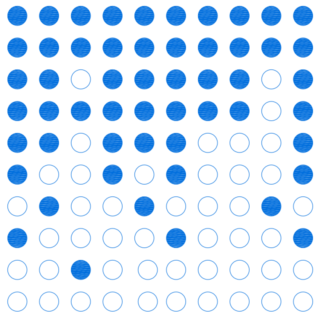
Introduction

Functionally Graded Materials (FGMs) were developed in 1984 for a space plane project to sustain high thermal barriers to overcome the shortcomings of traditional composite materials (AZO Materials, 2002). Traditional composites [Figure 1 a)] are homogeneous mixtures, therefore involving a compromise between the desirable properties of the component materials. Functionally Graded Materials (FGMs) are a class of advanced materials with spatially varying composition over a changing dimension, with corresponding changes in material properties built-in[56]. FGMs attain their multifunctional status by mapping performance requirements to strategies of material structuring and allocation [Figure 1 b)].

The manufacturing processes of conventional FGMs include shot peening, ion implantation, thermal spraying, electrophoretic deposition and chemical vapour deposition. Since additive manufacturing processes builds parts by successive addition of material, they provide the possibility to produce products with Functionally Graded properties, thereby introducing the concept often known as Functionally Graded Additive Manufacturing (FGAM). As this area of work is new, driven by academic research, and lacks available standardisation, there have been multiple different names proposed by different researchers in different publications as terms for this area, for example, functionally graded rapid prototyping (FGRP)[56], varied property rapid prototyping (VPRP)[57] and site-specific properties additive manufacturing[72]. However, even if there clearly is a great need for clarification of key terms associated with FGAM, this document does not include any attempts of alignment in terminology. This document is an overview of state of the art and the possibilities for FGAM enabled by present AM process technology and thus a purely informative document. Since this overview is based on available publications, and in order to facilitate cross referencing from these publications, this document has used the terms concerning FGAM as they are used in the original publications.



a) Traditional composite



b) FGM composite

Figure 1 — Allocation of materials in a traditional composite and an FGM composite

Additive manufacturing — Design — Functionally graded additive manufacturing

1 Scope

The use of Additive Manufacturing (AM) enables the fabrication of geometrically complex components by accurately depositing materials in a controlled way. Technological progress in AM hardware, software, as well as the opening of new markets demand for higher flexibility and greater efficiency in today's products, encouraging research into novel materials with functionally graded and high-performance capabilities. This has been termed as Functionally Graded Additive Manufacturing (FGAM), a layer-by-layer fabrication technique that involves gradationally varying the ratio of the material organization within a component to meet an intended function. As research in this field has gained worldwide interest, the interpretations of the FGAM concept requires greater clarification. The objective of this document is to present a conceptual understanding of FGAM. The current-state of art and capabilities of FGAM technology will be reviewed alongside with its challenging technological obstacles and limitations. Here, data exchange formats and some of the recent application is evaluated, followed with recommendations on possible strategies in overcoming barriers and future directions for FGAM to take off.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Abreviations

AM	Additive Manufacturing (see ISO/ASTM 52900)
AMF	Additive Manufacturing Format, see 8.4.2.1 (see ISO/ASTM 52900)
CAD	Computer Aided Design[48]
CAE	Computer Aided Engineering[14]
DED	Directed Energy Deposition, see Clause 6 (see ISO/ASTM 52900)
DMLS	Direct Metal Laser Sintering, the name for laser-based metal powder bed fusion process by EOS Gmbh[40]
EBM	Electron Beam Melting, the name for electron beam based metal powder bed fusion process by Arcam AB[40]
FAV	Fabricatable Voxel, see 8.4.2.2[19]