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Additive manufacturing — Feedstock materials —

Part 1: Guidelines for the selection of measurement methods for characterization of powder flow properties

Fabrication additive — Matières premières —

Partie 1: Lignes directrices pour la caractérisation des propriétés d'écoulement de la poudre

Reference number
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Foreword

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Introduction

The increased application of additive manufacturing creates a demand by stakeholders for a guidance document which describes process characteristics and performance regarding general test methods for the characterization of powder flow properties. In powder feedstock based processes, the flow properties of the powder are of decisive importance related to the process reliability of an additive manufacturing process and the quality of the manufactured parts. Characterization of powder flow properties is subject to numerous variables. The meaningfulness of the results of the measurement therefore depends on these variables. However, complete consideration of all variables might be neither cost-effective or time effective. Therefore, when measuring the flow properties, the nature and scope of the measurements to be conducted is an important issue.

The information contained in the document is applicable to the conditions that have an influence on flow properties, and the necessary information in a test report.

This information is provided is of interest to test equipment manufacturers, material suppliers, additive machine manufacturers, and additive manufacturing machine users.

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Additive manufacturing — Feedstock materials —

Part 1: Guidelines for the selection of measurement methods for characterization of powder flow properties

1 Scope

The document offers guidance on the selection of an appropriate method(s) to measure the flow properties of powders for powder feedstock based additive manufacturing processes. This document offers several definitions and parameters that affect powder flowability, in addition to several references for additional definitions and parameters.

It is intended that the guidance provided in this document not only applies to the virgin condition of the powder but also the used powder as a result of any number of successive builds. It is well known that the physical behaviour of the powder is also affected by the manufacturing process itself during the recovery and sieving cycles of the powder during the production processes. This condition of the powder going back into the system can be called out and monitored from successive builds to detect any drift of the powder properties.

This document applies to:

— the conditions that have an influence on flow properties, and

— the necessary information in a test report.

This document is aimed for test equipment manufacturers, material suppliers, additive machine manufacturers, and additive manufacturing machine users.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 and the following apply.

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 https://www.electropedia.org/

3.1
powder flowability
ability of a solid bulk material to flow

Note 1 to entry: Powder flowability is a function of multiple factors, and particularly powder size and distribution, see also ISO/ASTM 52907.

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[SOURCE: ISO/ASTM TR 52952:2023, 3.2, modified — Note 1 to entry added.]

3.2
angle of repose
angle formed with the horizontal by the surface of a conical heap of material falling slowly and regularly from a small height onto a horizontal stationary surface, it is expressed in degrees

[SOURCE: ISO 5048:1989, 2.2, modified — repetition of defined term deleted.]

3.3
rheology
science of deformation, behaviour and flow behaviour of materials

[SOURCE: ISO 3219-1:2021, 3.28]

3.4
cohesion
state in which the particles of a single substance are held together by intermolecular forces

[SOURCE: ISO 472:2013, 2.158]

3.5
consolidation
process in which a powder or compact is densified

[SOURCE: ISO 3252:2023, 3.2.16]

3.6
aeration
introduction of air or oxygen

[SOURCE: ISO 6707-1:2020, 3.5.1.52]

3.7
avalanche
mass of powder moving in a swift motion down over a precipice, as in a rotating drum

3.8
shear rate
property that indicates the forces required to shear one consolidated powder plane relative to another

3.9
flow rate
property that indicates the friction among constituent particles

4 Principle

4.1 General

Powders are bulk assemblies containing particles, liquid (i.e., moisture on the surface of the particle or within its structure), and gases, normally in the form of atmospheric gas (i.e. air). The interaction of these three phases governs bulk powder behaviour, often referred to as powder flow.

Powder flow is influenced by multiple factors covered by the following categories:

— Physical properties of the particles, including size distribution, morphology (including satellites), and surface properties.

— Cohesive strength due to Van der Waals, electrostatic and/or electromagnetic forces, as well as capillary bonds as a consequence of moisture adsorbed on the surface of particles.

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