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Additive manufacturing of ceramics — Feedstock materials — Characterization of ceramic slurry in vat photopolymerization

Fabrication additive de céramiques — Matières premières — Caractérisation de la barbotine de céramique en photopolymérisation en cuve

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Foreword

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This document was prepared by Technical Committee ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM Committee F42, *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).

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Additive manufacturing of ceramics — Feedstock materials — Characterization of ceramic slurry in vat photopolymerization

1 Scope

This document specifies the characterization of ceramic slurry for use as feedstock in vat photopolymerization additive manufacturing (AM) processes. The characterization includes the composition and properties of the slurry, such as solids content, dynamic viscosity, particle size distribution, chemical composition, and solid dispersion stability. This document also provides available methods on sampling and preparing slurry samples for testing.

This document does not deal with safety aspects.

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 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 3252, *Powder metallurgy — Vocabulary*

ISO 8213, *Chemical products for industrial use — Sampling techniques — Solid chemical products in the form of particles varying from powders to coarse lumps*

ISO 9276-1, *Representation of results of particle size analysis — Part 1: Graphical representation*

ISO 9276-2, *Representation of results of particle size analysis — Part 2: Calculation of average particle sizes/diameters and moments from particle size distributions*

ISO 11358-1, *Plastics — Thermogravimetry (TG) of polymers — Part 1: General principles*

ISO 13097, *Guidelines for the characterization of dispersion stability*

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

ASTM B243, *Standard Terminology of Powder Metallurgy*

ASTM C242, *Standard Terminology of Ceramic Whitewares and Related Products*

ASTM C1145, *Standard Terminology of Advanced Ceramics*

ASTM D6370, *Standard Test Method for Rubber — Compositional Analysis by Thermogravimetry (TGA)*

ASTM D7348, *Standard Test Methods for Loss on Ignition (LOI) of Solid Combustion Residues*

ASTM E1131, *Standard Test Method for Compositional Analysis by Thermogravimetry*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3252, ISO/ASTM 52900, ASTM B243, ASTM C242 and ASTM C1145 apply.

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ISO and IEC maintain terminology 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/

4 Sampling and preparation of test sample

Test samples shall be representatives of the ceramic slurry product batch. The sampling methods and devices for a certain quantity of ceramic slurry shall comply with the requirements mutually agreed upon by the supplier and customer. The obtained samples shall be suitable for examination and preparation in accordance with ISO 1513. The sampling procedure for testing raw ceramic powders prior to mixing with photocurable resins shall comply with the requirements specified in ISO 8213; otherwise, the methods specified in a suitable national standard, or another method mutually agreed upon by the supplier and customer, shall be used.

The number of samples to be taken depends on the sampling plan (e.g. ISO 28590) or supply agreements. Test samples shall be taken in consideration of the minimum sample amount as well as the repetitions required in each test method. Preparation of test samples as well as all operations for subsequent characterization tests are recommended to be performed under a UV-blocked laboratory environment.

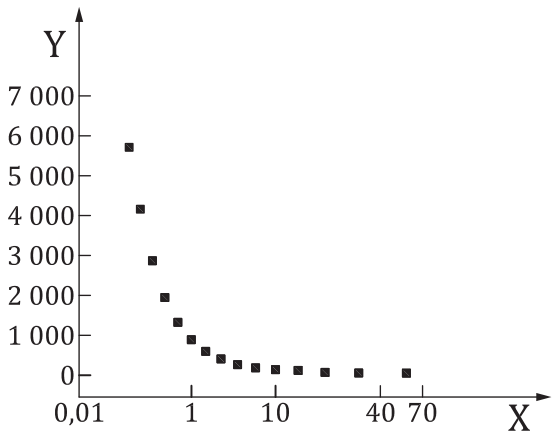
5 Slurry characterization

5.1 Ceramics content

Ceramics content refers to the amount of ceramic powder in the total slurry. The amount of ceramic powder that has been added during the slurry preparation process is expressed as mass fraction in SI unit (kg/kg) or more commonly mass percentage (wt %). If the proportion of ceramic powder in test sample is unknown, the ceramics content shall be estimated from the loss on ignition of ceramic slurry referring to ISO 11358-1, ASTM D6370, ASTM D7348, and ASTM E1131 (see Annex A).

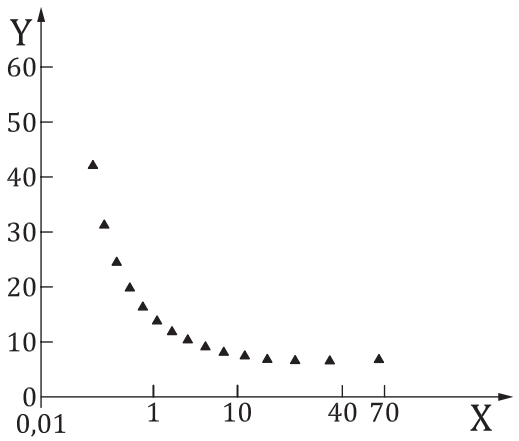
5.2 Dynamic viscosity

Dynamic viscosity describes the flow resistance of a fluid and is an important fluid property that is related to the internal friction within the fluid. Dynamic viscosity is usually expressed in $N \cdot s/m^2$, $kg \cdot m^{-1} \cdot s^{-1}$, Pa·s (or mPa·s) in SI units, or P (or cP) in CGS units.



X = shear rate in 1/s
Y = viscosity (Pa s)

a) Zirconia slurry



X = shear rate in 1/s
Y = viscosity (Pa s)

b) Alumina slurry

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