

EPMA European Additive Manufacturing Group

Quality Test for Selective Laser Melting (SLM) powder

“SLM-POWD”

Consortium Agreement

Issued “June 2016”

The Project – “SLM-POWD” as defined in Annex 1

The Contractors –

- Fraunhofer Institute for Manufacturing Technology and Advanced Materials, Wiener Str. 12, 28359 Bremen, **IFAM**

The Coordinator –

- The European Powder Metallurgy Association, Talbot House, 2nd Floor, Market St., Shrewsbury SY1 1LG, England: **EPMA**

The Members – **Paid up corporate EPMA members*** funding the Project

The Participants – **Paid up corporate EPMA Contractors*** and the Members

UV = unanimous vote of Members and Contractors; MV = majority vote of 2/3 members or higher

Heads

1. The Members and Contractors agree to cooperate in order to complete the Project according to Annex 1.
2. All information generated under the Project will remain confidential to the Members during the Project and for 3 years after delivery of the final written report to Members, and may only be disclosed to third parties (e.g. for dissemination purpose in PM Congress) with UV.

For “IFAM”: the contractor is obliged to publish in the usual scientific form the results of studies undertaken during performance of the project. The client gives their fundamental consent to such publication. The contractor will inform the client beforehand of any planned publication and will give them the opportunity of commenting on it within a reasonable period, at latest four (4) weeks after submission of the text intended for publication. A Member is entitled to refuse their consent to a publication if it is intended to publish company related data or, in connection with the granting of patent rights, if it is intended to publish any anticipatory information likely to constitute a bar to novelty. In such cases, the contracting parties will, without delay, seek to reach a special agreement governing the form and timing of rapid publication and taking due account of the legitimate interests of both parties. In case of abstract submission to any Congress and Conference, the contractor will circulate the text in due time to have the consensus from the client within two (2) weeks.

The Contractors agree to not carry out a similar project on **Quality test for Selective Laser Melting (SLM) powder** of the same alloy chosen for the project “SLM-POWD” with organisations other than the Members until completion of the project (delivery of the final report). The aforementioned obligation shall not apply to other entities of *Fraunhofer IFAM* other than its performing entity Fraunhofer IFAM – Powder Technology, Bremen research group.

3. The Members agree **to share equally the cost of the Project** (EUR 33000) through a Project Fee of maximum **EUR 6600** per Member. The required minimum number of Members is **five** unless the Members agree to exceed the maximum Project Fee.
4. **VAT:** VAT will be added to the Project Fee as appropriate but may be reclaimed according to local arrangements (e.g. "Reverse Charge" mechanism). All VAT numbers are to be provided to the EPMA.
5. The Members also undertake to provide the Contractor with the necessary materials (powders, specimen etc...) for the project. If no agreement on in-kind contribution between the industrial partners can be found or if the Consortium agrees to subcontract it internally or externally at additional costs, the EPMA will coordinate this task "Work Package 0" and charge equally each Member to cover the cost plus an administrative fee of 13 %.
6. **Payment Schedule:**
For Work Package 0: Full payment within one month of invoice if necessary.
For "SLM-POWD" project:
 - **50 % at the start,**
 - **50 % after completion** of the "SLM-POWD" Project and delivery of the final report.
7. New paying members may be admitted during the Project by UV on payment of an additional reasonable premium (10 %). The premium will be used to decrease the Project Fee for the Consortium Members.
8. Except for the deliverables of Annex 1, each Participant will retain the Intellectual Property for any other outcomes of the Project.
9. **Warranty.** The contractor's warranty extends solely to the use of due scientific diligence and to compliance with accepted engineering practice. The contractor does not guarantee that the desired objectives of the research and development project will be achieved.
10. **Liability.** The contractor is liable solely for wilful actions and gross negligence. Liability for proven damage is limited to the amount of the contractual sum.

All the terms of this agreement may be changed by UV, except for 4, 9 & 10.

Coordination will be undertaken by the EPMA, who will have responsibility for invoicing, day to day liaison with the Contractors and keeping Members informed. The EPMA will operate under the same confidentiality agreement as Members and the EPMA President will arbitrate any unresolved disputes.

Signatures: signed individually by all Members and Contractors

ORGANISATION:

VAT NUMBER:

NAME:

DATE:

STAMP AND SIGNATURE:

***If you are not an EPMA member please contact Dr Olivier Coube, EPMA Technical Director, oc@epma.com**

ANNEX 1

EAMG European Additive Manufacturing Group

Proposal for a Club Project on Quality test for Selective Laser Melting (SLM) powder

“SLM-POWD”

Overview of the proposal

Metal powders are the basic materials for powder bed-based Additive Manufacturing (AM) processes as Laser Beam Melting (LBM) or Selective Laser Melting (SLM- Figure 1) also called Laser Beam Melting (LBM). Due to the narrow process windows of AM processes, these materials have to fulfill special specifications concerning their chemical composition, particle size distribution and particle morphology.

Also powder bed-based processes as binder jetting or binder printing processes will profit from the project's results as the powder requirements are quite similar and results will be transferable.

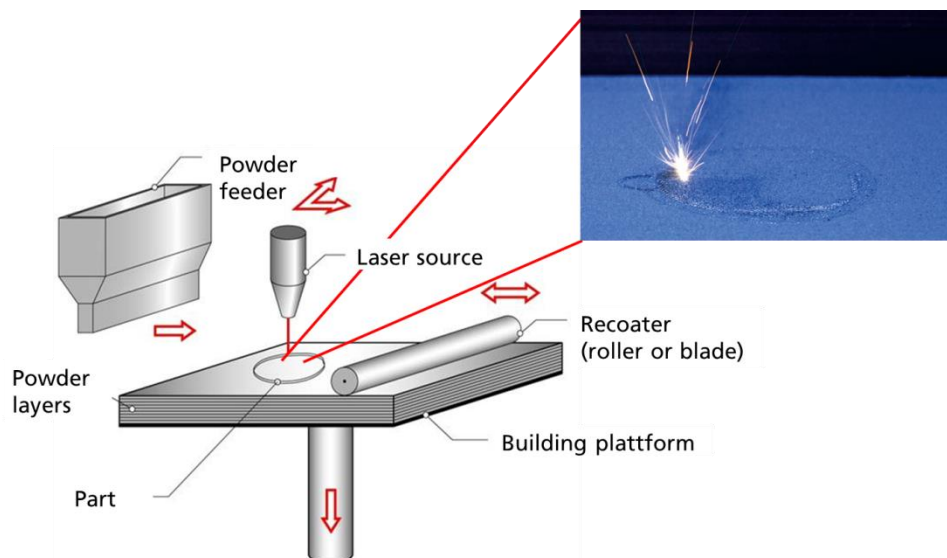


Figure 1: Principle of the SLM or LBM process

Especially particle size distribution, particle morphology (see Figure 2 and Figure 3) accompanied by humidity have great influence on the flowability of metal powders. A defined flowability again is needed to end-up with a reproducible powder bed surface and with that, a robust AM process.

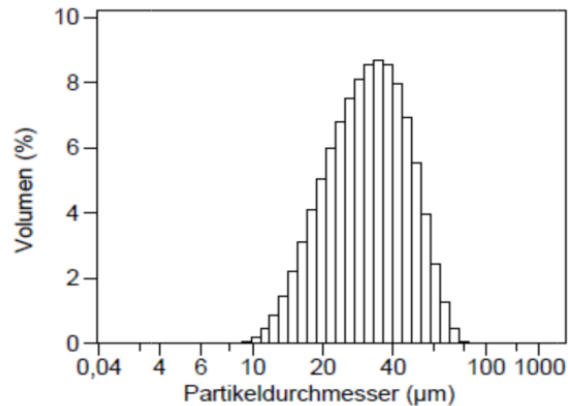


Figure 2: Particle size distribution of a metal powder suitable for SLM or LBM

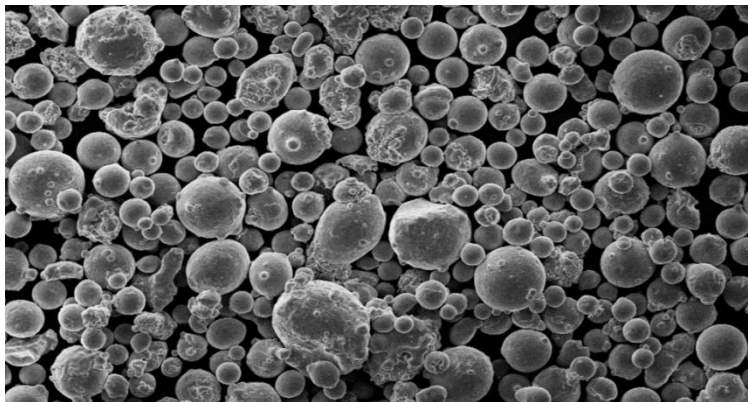


Figure 3: Particle morphology of a metal powder suitable for SLM or LBM

The project aims at getting a better understanding of how the specifications of AM powder materials have to be differentiated from standard metal powder specifications. According guidelines and handling suggestions for suppliers and users will be developed.

Objectives of the project are:

1. study the applicability of one metal powder (to be defined) for the Additive Manufacturing process of Selective Laser Melting
2. setting up a guideline on how to characterize and specify AM powder for SLM
3. setting up a guideline on how to find the right laser parameters to process powder with SLM

Work packages:

0. Supplying of Materials

The Members undertake to provide the Contractors with the necessary materials (powders, specimen etc...) for the project.

Cost:

Contribution by Members (industrial partners): cost not included here. If no agreement on in-kind contribution between the industrial partners can be found, the EPMA will coordinate the WPO and charge equally each Member to cover the cost of WPO plus an administrative fee of 13 %.

1. Powder specification and acquisition – 1 months

1.1. Definition and specification of one powder among all partners. Materials to choose from are:

- Stainless steels
- Nickel-based alloys
- Titanium alloys
- alternative alloys

Note: the material's specifications has to be close to standard AM powders, as only a parameter adaptation of SLM parameters – not a completely new parameter development – will be part of the project (see work package 3)

If no agreement can be found, the powder will be chosen by Fraunhofer and EPMA.

1.2. Based on experience with widely used standard AM powders, basic powder specifications will be made including chemical composition, particle size distribution and particle morphology

1.3. Production/acquisition of defined powders by project consortium

2. Execution and description of a powder characterization – 2 months

2.1. Powder characterization before and after the built job. Characteristics will be the following:

- particle size analysis by laser granulometry
- scanning electron microscopy with EDX-analysis
- bulk density/tap density
- angle of repose
- moisture determination
- flowability, fluidization and granulation tests
- coatability tests inside SLM system

2.2. Preparation of a guideline for powder characterization

3. Execution and description of finding of SLM parameters – 2 months

3.1. Identification of an adequate and transferable energy density (J/mm^3) for the powder, based on standard SLM process parameters as:

- laser power
- laser velocity (scan velocity)
- laser line distance (so called hatch distance)

by successive variation to achieve geometrically correct and dense parts.

- 3.2. Preparation of a guideline for finding of SLM parameters
4. **Production, heat treatment and test of tensile test specimens – 2 months**
 - 4.1. Build-up of tensile test specimens in 3 building directions from the defined powder
 - 4.2. Application of standard heat treatment after built
 - 4.3. Tensile testing of the specimens
 - 4.4. Comparison with standard material values
 - 4.5. Preparation of report
5. **Project Management – 6 months**
 - 5.1. Project Management
 - 5.2. Preparation of Final Report (ppt presentation or written report on request)

Timeline for work packages (months):

No.	Title	1	2	3	4	5	6
1	Powder specification and acquisition						
2	Development of a guideline for powder characterization						
3	Development of a guideline for the finding of SLM parameters						
4	Production, heat treatment and test of tensile test specimens						
5	Project Management, including report						

Milestone: end of month 4 - guidelines for powder characterization and the finding of SLM parameters for one alloy have been set-up

Duration: 6 month, 2 meetings (kick-off/final)

Budget: 33.000 € (+ VAT if applicable)
including Fraunhofer IFAM: 30.000 €
and EPMA (Management fee): 3.000 €

Minimum expected partners: 6

Contact:

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