

EPMA European Additive Manufacturing Group**Proposal for a Club Project on Quality Test for Laser Beam Powder Bed Fusion (PBF)****“PBF-POWD 2”****Consortium Agreement**

Issued “June 2018”

The Project – “PBF-POWD 2” 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, Haughmond View, Sitka Drive, Shrewsbury Business Park, Shrewsbury, SY2 6LG, United Kingdom: **EPMA**

The Members – **Paid up corporate EPMA members¹** 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 Laser Beam Powder Bed Fusion (PBF) “PBF-POWD 2”** of the same alloys chosen for the project “PBF-POWD 2” with organisations other than the Members until completion of the project (delivery of the final report).

¹ If you are not an EPMA member please contact Dr Olivier Coube, EPMA Technical Director, oc@epma.com

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 50000) through a Project Fee of maximum **EUR 8334** per Member. The required minimum number of Members is **six** unless the Members agree to exceed the maximum Project Fee.
4. The Members who did not participate in the project “SLM-POWD” may participate in the PBF-POWD 2 project by settling a “SLM-POWD” results access premium of EUR 3,667 at the start of the PBF-POWD 2 Project. The premium less a 13% EPMA Management fee will be used to decrease the PBF-POWD 2 Project Fee for the SLM-POWD Consortium Members. SLM-POWD results will be then provided to the new Members.
5. **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.
6. 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 %.
7. **Payment Schedule**:
For Work Package 0: Full payment within one month of invoice if necessary.
For “PBF-POWD 2” project:
 - **50 % at the start,**
 - **50 % after completion** of the “PBF-POWD 2” Project and delivery of the final report.
8. 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.
9. Except for the deliverables of Annex 1, each Participant will retain the Intellectual Property for any other outcomes of the Project.
10. **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.
11. **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:

ANNEX 1

European Additive Manufacturing Group EuroAM



Proposal for a Club Project on Quality test for Laser Beam Powder Bed Fusion (PBF)

“PBF-POWD 2”

Overview of the proposal

Metal powders are the basic materials for powder bed-based Additive Manufacturing (AM) processes as Laser Beam Melting (LBM) also called Selective Laser Melting (SLM) or Laser Powder Bed Fusion (LPBF). Due to the narrow process windows of AM processes, these materials have to fulfill special specifications concerning their chemical and rheological properties.

Also powder bed-based processes as Binder Jetting (BJ) or Fused Filament Fabrication (FFF) will profit from the project's results as the powder requirements are quite similar and results will be transferable.

Especially particle size distribution, particle morphology (see Figure 1 and Figure 2) 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.

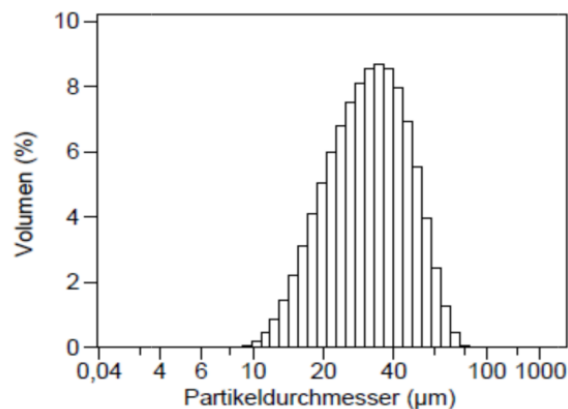


Figure 1: Particle size distribution of a metal powder suitable for SLM or LBM

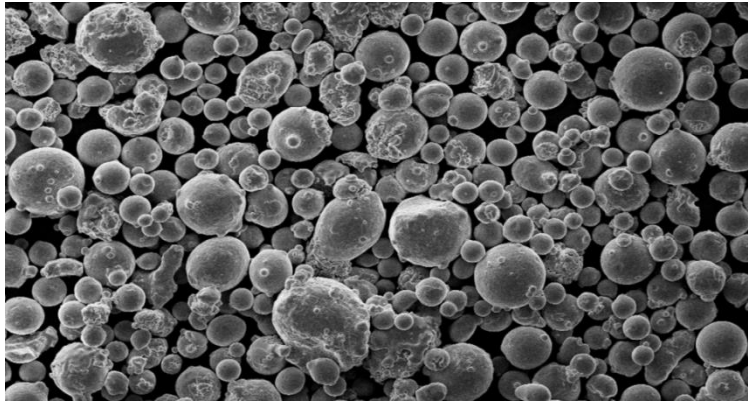


Figure 2: Particle morphology of a metal powder suitable for SLM or LBM

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.

This proposal offers the possibility to include a second powder to be tested. In this case the consortium may either choose one alloy from two suppliers or two different alloys.

Objectives of the project are:

1. Study the applicability of two metal powders (to be defined) for the Additive Manufacturing process of Laser Beam Powder Bed Fusion (L-PBF)
2. setting up a “guideline” on how to characterize and specify AM powder for L-PBF
3. setting up a “guideline” on how to find the right laser parameters to process powder with L-PBF

All test executions will be prepared and streamlined based upon and taking into account the lessons learned in previous project “Quality test for Selective Laser Melting (SLM) powder - SLM-POWD”

Work packages:

0. Supplying of Materials

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

The powders should be decided at the kick-off meeting between the participants by MV. If no agreement can be found for the powders choice, the powders will be chosen by Fraunhofer and EPMA.

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 two powders among all partners (see WP 0). Materials to choose from could be:

- Maraging Steel 1.2709
- AlSi10Mg
- Ti6Al4

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)

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 – 3 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 (by thermogravimetric and coulometric analysis)
- flowability, fluidization and granulation tests

2.2. Organization of and powder handling for all tests offered and executed by consortium members

2.3. Documentation of all tests leading to a “guideline for powder characterization”

3. Execution and description of finding of SLM parameters – 3 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 – 4 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 – 8 months

5.1. Project Management

5.2. Preparation of Final Report (ppt presentation)

The contractor IFAM should provide the consortium with short progress reports every three months, minutes and presentations after each meeting or teleconference and a final report at the end of the project. Practical work in the project would commence once the powder(s) as decided in WPO are available. Two or Three meetings with all contractors would be held, a kick-off meeting, a possible mid-term meeting (physical or teleconference) and one wind-up meeting at project completion. Work at partner organisations to prepare materials should start as soon as the project has sufficient members to meet the financial requirements.

Timeline for work packages (months):

No.	Title	1	2	3	4	5	6	7	8
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								

Duration: 8 months, 3 meetings (kick-off/mid-term/final)

Budget: 50.000 € (+ VAT if applicable)
including Fraunhofer IFAM: 45.000 €
and EPMA (Management fee): 5.000 €

Minimum expected partners: 6

Maximum expected partners: 10

Contact:

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