ANNEX 1

European Additive Manufacturing Group EuroAM

Proposal for a Club Project on the influence of air humidity on the water content and flowability of powders for additive manufacturing

"Hum-Flow"

Overview of the proposal

The flowability of metal powders is crucial for all powder bed-based Additive Manufacturing (AM) processes such as Laser Beam Melting (LBM), Laser Powder Bed Fusion (LPBF) or Binder Jetting (BJ). The flowability of such powders is on the one hand influenced by intrinsic powder properties such as particle size distribution and morphology. On the other hand, extrinsic properties such as air humidity also have an effect. Exposed to humidity, powders tend to absorb water. The amount of water depends on the powder and its properties. Figure 1 shows the influence of different air humidity levels on the water content in a 316L powder. Moreover, the combination of various the intrinsic and extrinsic effects also plays an important role. To ensure a defined and reproducible flowability of powders and therefore a robust AM process, a comprehensive understanding of the influence of the air humidity on the flowability is crucial.

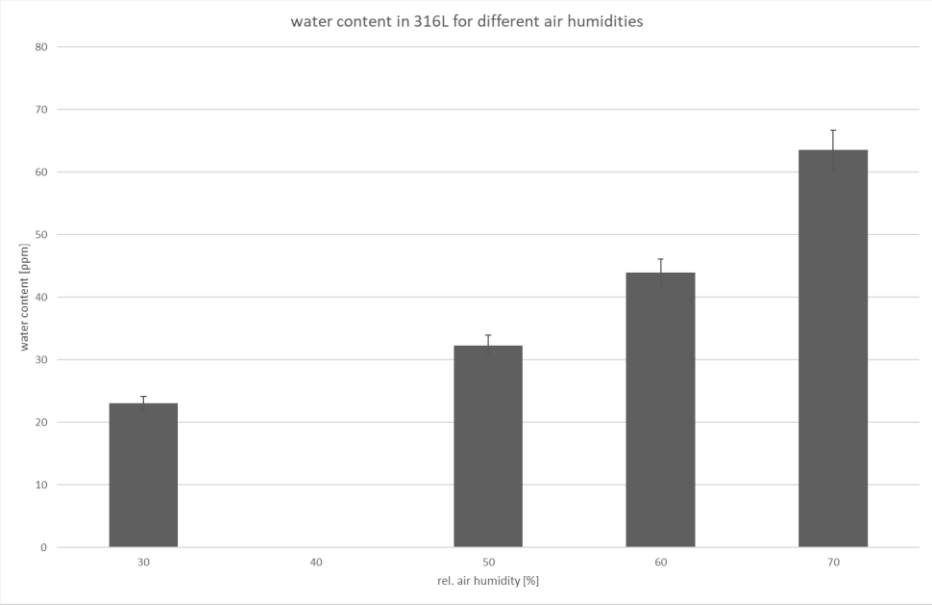

Figure 1: Water content of a 316L powder exposed too different air humidity levels

The project aims at getting a better understanding of the correlation between particle size, particle morphology, specific surface area, alloy composition and the adsorption of water in metal powders when exposed to different air humidity levels.

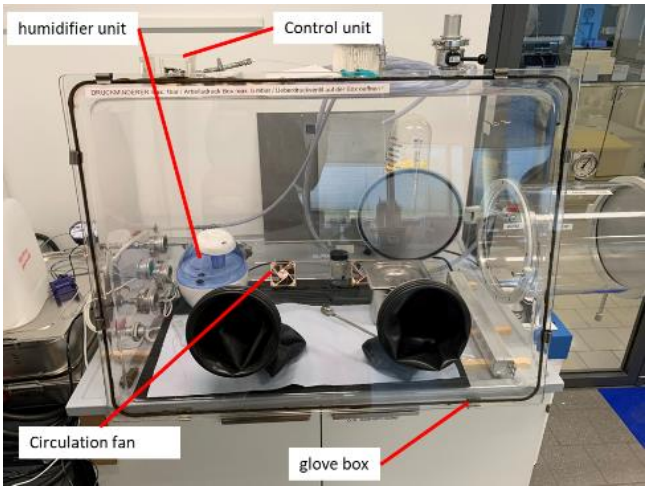

Figure 2: Specially equipped glove box for the exposition of powders to defined air humidity levels

Objectives of the project are:

1. Exposition of different AM powders to different air humidity levels (see Figure 2)
2. Investigation of the influence of different air humidity and exposition durations on the flowability of selected AM powders
3. Investigation of the influence of intrinsic powder properties like particle size, morphology and specific surface area on the adsorption of water through air humidity

Work packages:

1. Powder specification and acquisition – 1 months

1.1. Definition and specification of three powders (different alloys and/or different particle size distributions) among all partners. Materials to choose from could be:

- Stainless steel 316L
- Stainless steel 17-4PH
- AlSi10Mg
- Ti6Al4

Note: Nickel-based and other hazardous materials will not be tested. The project will have its focus on metal powders, but could also investigate ceramic powders or powders plus flow additives.

1.2. The partners will specify the testing conditions (air humidity level and exposition durations).

The testing box at Fraunhofer IFAM (see Figure 2) allows relative air humidity levels between 30 % and 70 % at room temperature. The exposition durations should be limited to a maximum of 6 hours.

2. Powder characterization – 1 month

Powder characterization regarding:

- particle size analysis and morphology by dynamic image analysis (CamSizer)
- scanning electron microscopy with EDX-analysis
- determination of the water content (by coulometric analysis)
- dynamic flowability tests (RPA)

3. Execution and description of finding of humidification tests – 2 months

The selected powders will be exposed to defined humidity levels for defined durations. A specially equipped glove box will be provided by IFAM. While exposed, the powders will be moved with the aid of a rotor and to ensure a uniform moistening. For each combination of air humidity and exposition duration the powders will be characterized regarding:

- dynamic flowability test (RPA)
- determination of the water content (coulometric analysis)

4. Analysis of correlations between exposition humidity levels, exposition durations, intrinsic powder properties and flowability – 2 months

Based on the humidification tests the flowability of all powders will be characterized regarding the influence of:

- the exposition humidity
- the exposition duration
- the resulting water content of the powders
- the chemical composition of the powders
- the specific surface area of the powders
- the particle morphology of the powders

5. Project Management – 7 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 videoconference and a final report at the end of the project. Practical work in the project would commence once the powder(s) as decided in WP0 are available. Two or three meetings with all contractors would be held, a kick-off meeting, a possible mid-term meeting (physical or videoconference) 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
1	Powder specification, powder acquisition and specification of testing conditions							
2	Powder charaktrerisation							
3	Humidification tests							
4	Analysis of correlations							
5	Project management, including report							

Duration: 7 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

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