

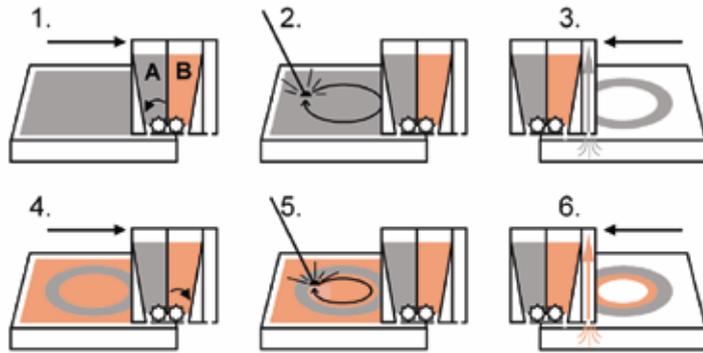
A more efficient and competitive way to space,
leading to new possibilities in the sky and on earth



Factsheet #5.2

Maturation of Additive Manufacturing Methods

Powder bed fusion using a laser beam (PBF-LB/M)



Powder bed fusion of metals using a laser beam (PBF-LB/M) is one of the most industrially relevant additive manufacturing techniques. Lately, extensive research has advanced the method for producing three-dimensional multi-material parts (3D MM). These parts can incorporate specific materials at chosen locations, enabling customized physical, mechanical, and metallographic properties, particularly valuable in aerospace for innovative components.

The 3D MM PBF-LB/M process is comparable to mono-material production, as both use a laser to build geometry layer by layer by melting and solidifying powder. To process multiple materials, conventional PBF-LB/M systems require modifications.

Key adaptations include dual-material coating and layer-wise removal of one material before applying the other. Coating is done over the full surface: a homogeneous powder layer is applied, exposed by the laser, then removed by suction. The second material is then coated, filling the cavities of the first, and also exposed by the laser. This cycle repeats until the part is complete (as seen in the picture above). Multiple materials can thus be processed within and across layers.

This technology represents a disruptive innovation compared to methods such as welding or soldering.

Pros and Cons

- ⊕ **Production of innovative components from 2 materials**
- ⊕ **Weight reduction of up to 30%**
- ⊕ **Fewer manufacturing steps**
- ⊕ **Lead time comparable to conventional manufacturing**
- ⊖ **Challenging material combinations**
Due to porosity, cracks, delamination...
- ⊖ **Powder needs to be separated and reprocessed**
- ⊖ **High investment costs (equipment)**
- ⊖ **Certification for aerospace needs further development**

Companies involved



Picture on the left:

Schematic representation of the multi-material PBF-LB/M process by Schroeder, T., Lehmann, M., Horn, M., Kindermann, P., Uensal, I., Michal, F., Lippus, A., Schlick, G., and Seidel, C. (2024) "Transition zone parameter development in multi-material powder bed fusion: a general approach," Prog Addit Manuf, vol. 9, no. 3, pp. 613–624, doi: 10.1007/s40964-024-00663-4.

Key parameters

**Inconel 718
Superalloy**

Iron + Nickel
+ Chromium ...

PSD < 36µm

**Titanium
Alloy 6-4**

Titanium + Aluminum
+ Vanadium

PSD > 45µm

For the production of two materials that cannot be magnetically separated, different particle size distributions (PSDs) of the powders must be used when manufacturing parts via 3D MM PBF-LB/M. This was the case for the alloys IN718 and Ti64 processed in the project, which is why Ti64 with a larger PSD and IN718 with a smaller PSD were used. The powder materials could then be separated and reused after processing.

from

TRL 1 >>>>

no experience for processing the material combination of Ti- (Ti6Al4V) and In-base (NiCr19Fe19Nb5Mo3) alloy

to

>>>> **TRL 4**

will be tested on specimens that will be characterized

Expectations for testing phase

The development of a multi-material laser beam melting process specifically tailored for this material combination represents a significant advancement in additive manufacturing techniques. It lays the foundation to produce more complex multi-material components with enhanced properties in the future.

The successful separation of mixed powders within a closed-loop process opens up new opportunities for manufacturing different material combinations across various applications beyond the initial use case.

Additionally, the range of materials that can be effectively combined is expanded, fostering innovative designs and improving overall performance.