Multi-Material Powder Bed Fusion – Chances and Challenges

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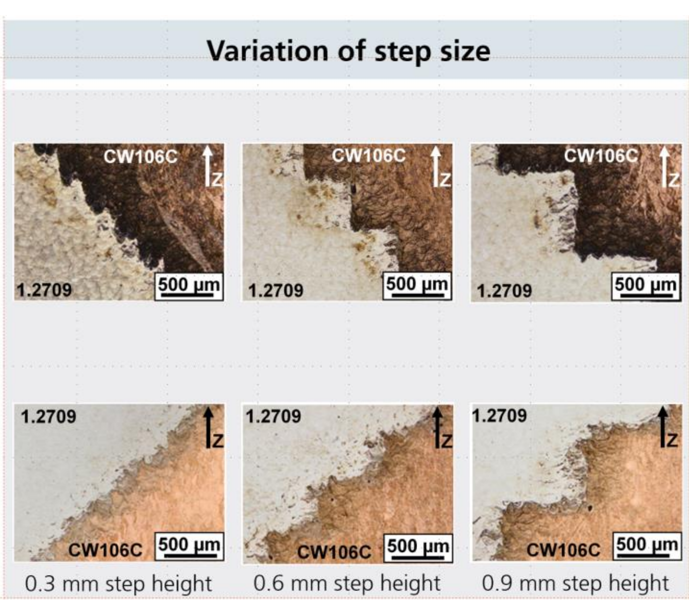
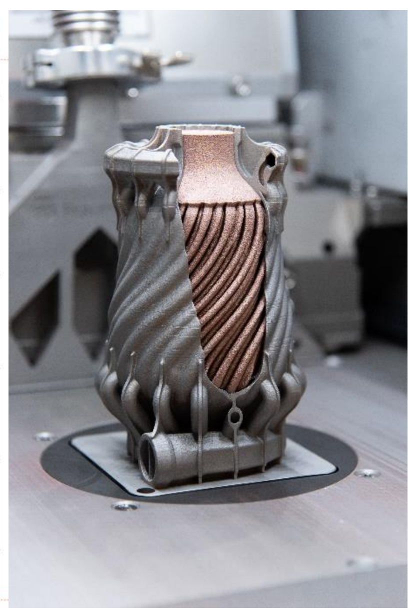
Highlights of Presentation

- Multi-material additive manufacturing opens up new design spaces and enables components that have not been possible until today.
- Several paths can lead to very complex multi-material components. Newest technological developments will be shown.
- Technological use-cases from nuclear fusion, space propulsion, tooling and e-mobility will be shown.
- Challenges arise from feedstock reuse, metallurgical bonding, mechanical testing, design and part optimisation. First remedies for these challenges will be addressed.

Graphical Abstract





Possible solutions on multi-material interface design (left) and demonstrator component (right)

Textual Abstract

Multi-Material Powder Bed Fusion (MM-PBF) is a cutting-edge additive manufacturing technique that extends the capabilities of traditional Powder Bed Fusion by enabling the simultaneous processing of multiple materials. This innovation offers significant opportunities for creating components with customized material properties, such as tailored mechanical, thermal, and electrical characteristics, within a single manufacturing step. The ability to combine different materials in a single build process opens new avenues for design innovation, allowing engineers to optimize parts for specific applications, such as lightweight structures with reinforced sections or components with integrated conductive pathways.

Despite its promising potential, MM-PBF faces several challenges that must be addressed to ensure its successful implementation. One of the primary hurdles is the choice of materials and the corresponding process parameter development to realize high quality parts. Special focus needs to be given to the process parameters on the material interface.

Moreover, the complexity of multi-material systems requires advanced simulation and modeling techniques to predict material behavior accurately. Part optimization for two (or more) materials within several physical domains is still a developing field.

Material cross-contamination and separation of powder materials is another crucial point. Powder reuse is key in order to realize an economically feasible process while cross-contamination effects need to be understood in detail in order to realize components for high-end applications.

In conclusion, while MM-PBF holds great promise for revolutionizing manufacturing processes and expanding design possibilities, overcoming its challenges demands a concerted effort from researchers and industry professionals. Continued advancements in materials science, process engineering, and computational modeling will be key to unlocking the full potential of MM-PBF, leading to innovative solutions across various high-demand sectors, including space, nuclear fusion and medical applications.

In this talk, Georg Schlick will show the state of the art in Multi-Material Powder Bed Fusion, examine open questions regarding the challenges and show several use cases.