

Hybrid Additive Manufacturing of Copper-Metal-Components – Technology Analysis and Further Directions

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Abstract: With increasing technology maturity, additive manufacturing (AM) of copper components becomes a viable option if lot sizes, costs, and technological advantages match the peculiarities of AM processes. Beyond AM for standard components, the manufacturing of multi-material components experiences rising research interest. In this study, the current state of multi-material powder bed-based AM with copper and other metallic materials is analyzed. An approach is presented, which allows the combination of AM and conventional processes by manufacturing onto conventionally manufactured substrates made from different materials, as well as the utilization of tailored material properties through AM.

Keywords: Additive manufacturing, PBF, copper, multi-material, hybrid manufacturing

1 Introduction

The use of AM processes has become established alongside conventional manufacturing methods. The production of components with small batch sizes, prototypes, internal structures, and undercuts are typical application criteria for AM. Research increasingly focusses on the processing of different materials and combination with conventional manufacturing processes, where the term of hybrid manufacturing is often used (Doddapaneni et al., 2023; Schneck et al., 2021). This offers the potential to replace assemblies with monolithic components that do not require any additional assembly or joining processes and offer application advantages such as lower weight or higher reliability. A widely used AM process, particularly for metallic materials, is laser-based powder bed fusion of metals (Ampower GmbH & Co. KG, 2025). This process and its abbreviation PBF-LB/M is defined in the standard EN ISO/ASTM 52911-1:2019 and schematic illustrations of common processes are provided in the VDI standard 3405:2014-12, which Figure 1 (A) is based on (3405, 2024). The process is based around the layer-wise coating of a substrate plate with a metallic powder, which is fused together by a laser beam, according to the part shape for this specific layer. After the complete part contour is scanned, the platform holding the substrate plate is lowered and the coating, as well as the laser exposure start again. This is repeated until the complete part is manufactured, which can then be removed from the building chamber. Figure 1 (B) shows pure copper specimens manufactured via PBF-LB/M on the substrate. The different colors seen here are a consequence of varying stages of oxidization of the powder.

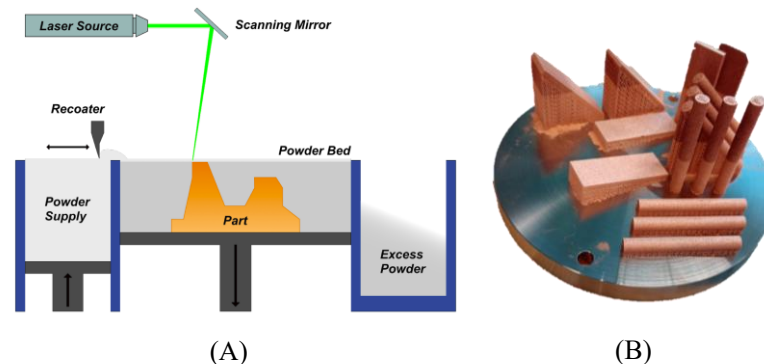


Figure 1. (A) Schematic illustration of the PBF-LB/M process (B) example of manufactured parts

Due to the potential of AM and the special material properties, there is growing research interest in the processing of copper and copper-based materials using AM. Particularly the outstanding electrical and thermal conductivity are in the focus of research (Ho et al., 2025). Despite these incentives to apply AM parts fabricated of copper, the industrial implementation is still limited, compared to other groups of metals. This can be attributed to several factors, like processing challenges and difficulties in process parameter optimization (Vahedi Nemani et al., 2024). Simultaneously, there is a demand for copper that goes beyond manufacturing of components with high relative density and also concerns its combination with other materials (Schäfle et al., 2025). To fulfill a desired function, components can be made not only from different materials, but their material condition and properties can also be adjusted using select manufacturing processes. Examples for this, the complex interplay of manufacturing with the material condition of metallic materials and corresponding properties are nickel based alloys for their high temperature abrasion resistance and forged steel (Liu et al.,

2023; R et al., 2025). Desired properties of metals cannot always be realized by AM utilizing PBF-LB/M, as the manufacturing conditions are fundamentally different, making a combination of processes and joining necessary. Properties connected significantly to grain size, grain morphology, or microstructure changes under elevated temperatures are difficult to adjust through PBF-LB/M. A prominent example is the high temperature alloy IN738LC, which shows diminished properties after PBF processing, compared to conventional processing routes (Mayr et al., 2024).

As this study shows, the demand for different manufacturing methods to utilize the full potential of copper and copper alloys, in connection with other materials, is growing steadily. Consequently, the current state of hybrid and multi-material AM with a focus on powder bed-based processes is assessed. The following research questions are answered utilizing the results of an analysis of existing research:

RQ1: How is the term *hybrid manufacturing* understood in the analyzed research and which processes are utilized?

RQ2: Which research directions of multi-material and hybrid (powder bed-based) copper AM, regarding utilized materials, research aims, and desired advantages exist?

In addition, based on the research presented, an approach for using PBF systems to apply structures onto existing components using AM with minor adjustments is presented. Using the example of copper AM, conceivable applications and demonstrators are presented that can be realized in the manner described. The advantages and disadvantages of the approach are discussed and compared with relevant preliminary work.

2 Method

Research is conducted by two independent reviewers using scientific literature databases: ProQuest, Web of Science, OpenAlex, Open Access Theses and Dissertations (OATD), and the German National Library are used. The analysis follows the PRISMA approach (preferred reporting items for systematic reviews and meta-analyses). Disagreements during screening and merging of results are resolved by a third supervising reviewer. The evaluation focusses on specialist literature in the form of scientific articles that have undergone double-blind peer review or dissertations. The topic of interest concerns AM of copper or copper-based alloys. These are to be processed in a hybrid manner, incorporating other materials. This analysis focusses on PBF-LB/M because of the high relevance of this process for metallic materials AM and distinctive features like high thermal gradients and high solidification growth rates. Process characteristics have a major influence on the feasibility of different metallic interfaces and compatibility of metallic materials. PBF-LB/M is highly sensitive to mismatches in properties of the fused metals and therefore justifies a separate consideration (Wang et al., 2026). Since German-language directories were also explicitly used, search terms in German are included. The following search query was used to obtain the literature described: (“copper” OR “cu” OR “kupfer”) AND (“hybrid manufacturing” OR “multi-material” OR “multimaterial”) AND (“additive manufacturing” OR “additive fertigung” OR ‘pulverbett’ OR “powder bed”). This search query is deliberately designed to include literature, which is possibly out of scope of this study, like research concerning directed energy deposition (DED) processes. This aims to reduce the amount of relevant studies not found due to the query. Figure 2 shows an overview of the literature found and how all studies are sorted into a relevant selection of scientific articles. Articles are screened based on their title and afterwards their content.

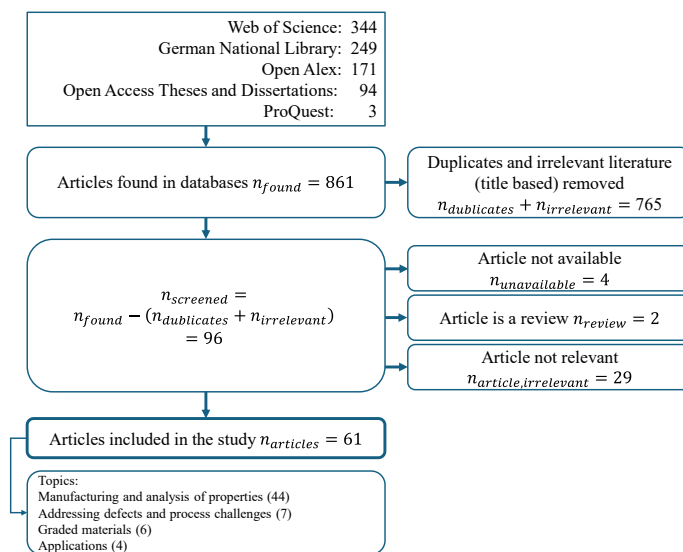


Figure 2. Number of studies extracted from databases and final number of studies after sorting and removing

From 861 articles, 61 remain, which can be categorized into four main research topics: manufacturing and analysis of properties, addressing defects and process challenges, graded materials, and applications. This analysis connects the findings within the scope to studies, which are not exactly addressing the proposed focus of the analysis. This is a deliberate choice, to allow the evaluation of similar technologies and manufacturing methods, which can produce similar parts or have similar effects on materials during manufacturing, for example due to periodic thermal energy input, layer-wise build-up, and powder-based raw material. A process which fits these criteria of similarity is DED. Based on the results of the analysis of existing research, an approach to hybrid manufacturing of components is presented and discussed in terms of its properties and implications on hybrid manufacturing. Application scenarios which require the use of hybrid manufacturing, and future research directions are explained in detail.

3 Hybrid Additive Manufacturing of Copper-Metal-Components – Current State

3.1 Metadata of reviewed publications

The country of affiliation of the first author and the year of publication show clear trends, which are visualized in Figure 3. The countries of origin for the studies evaluated show a high degree of overlap with the countries that are cited in studies on the market structure of the AM industry as key drivers of the technology, for example based on the number of patents filed (Ampower GmbH & Co. KG, 2025; Buonafede et al., 2018). The annual number of publications shows a clear upward trend, with a considerable increase in new studies in 2025, when with 22 studies nearly double the amount of 2024 was published. An early study was presented in 2014, where a retrofitted PBF system is used to allow for a multi-material deposition (Liu et al., 2014). Besides PBF-LB/M the most often used AM process in the context of copper and multi-material manufacturing is DED. Additionally, combinations or process variants are applied to a lesser extent, for example through pairing PBF-LB/M with binder jetting (BJ) (Lee et al., 2024).

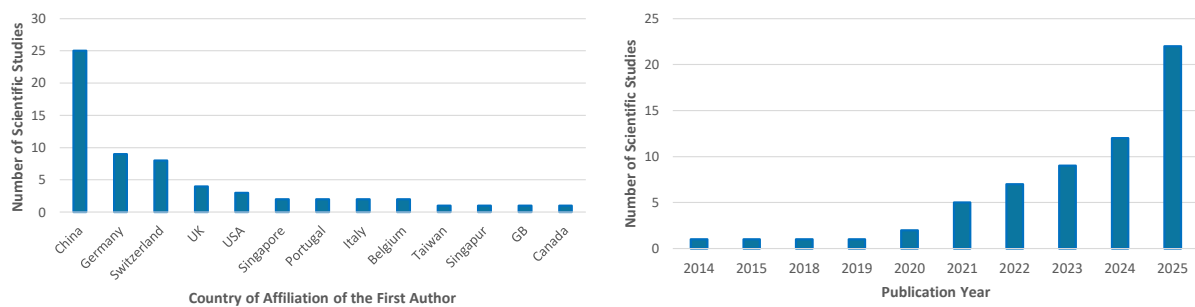


Figure 3. Bar diagrams illustrating the country of affiliation of the first author and the year of publication

3.2 Material combinations and interfacial defects

Figure 4 provides a comprehensive overview of the studies classified as relevant for the analysis of multi-material AM with copper, based on PBF-LB/M. Materials processed in addition to copper are color marked for every literature source, with the main element symbol stated. The processed material group besides copper alloys is stated and hybrid processes are marked with an asterisk. Examples for copper alloys used are bronze: CuZr, CuCr1Zr, K220, C18400 and GRCop-42 (Chen et al., 2022; Chueh et al., 2024; Li et al., 2024a; Obeid et al., 2026; Sun et al., 2024; Wang et al., 2025). 40 of 61 studies consider iron-based materials exclusively. The steel grade 316L is predominantly used and examined, as it is a widely utilized alloy, which offers the opportunity of combining a mechanically stronger material to copper (Baganis et al., 2025; Bulloch et al., 2025b; Chen et al., 2021; Chen et al., 2020; Liu et al., 2022; Mao et al., 2023; Wang et al., 2023; Yan et al., 2025; Yang and Liu, 2025). Steel grades like 1.2316 or 1.2709 are also used (Anstätt, 2020; Li et al., 2024b). To a higher extent than commonly used steels, nickel and nickel-based alloys offer extraordinary advantages regarding mechanical strength as well as fatigue and oxidation resistance, especially under high temperatures. Consequently with 13 studies, analyzed research is focused on this material group besides steels (Bulloch et al., 2025a; Larini et al., 2025; Li et al., 2025; Marques et al., 2022; Özsoy et al., 2025a; Walker et al., 2022; Wang et al., 2025; Yan and Li, 2024; Yang et al., 2025; Zhang et al., 2023b; Zou et al., 2025). Especially for applications concerned with mobility and vehicles, aluminum alloys offer an increased mechanical strength compared to copper or copper alloys, while having a lower density than iron-based materials, making parts lighter. In this light, studies are carried out to investigate manufacturing and bonding of copper-aluminum parts, where the formation of intermetallic phases like Al₂Cu can be observed (Bernet et al., 2025; Sing et al., 2015). This is an noteworthy effect, as the formation of these hard phases can lead to diminished mechanical properties and embrittlement of the intermediate layers (Sing et al., 2015). Intermetallic phases, cracking and therefore insufficient bonding is also relevant for titanium based materials fused with copper based alloys (Wei et al., 2022a; Zhang et al., 2023a). The research investigated introduces interlayers, adapted laser processing strategies and a grading of compositions in the transition zone as possible strategies for mitigation. Tungsten offers an outstanding hardness and consequently abrasive resistance, as well as resistance to plasma radiation, making it an ideal material for the application

in energy systems. The combination with copper offers the potential to enhance the thermal conductivity of radiation resistant parts, but joining these dissimilar materials during PBF-LB/M is challenging. The material combination of copper alloys and tungsten was nevertheless investigated and a good bonding strength can be achieved by applying a stainless-steel interlayer (Wei et al., 2022b). Only considered in one paper, but highly relevant for thermally demanding environments, is the combination of copper alloys with cobalt-based materials. Especially for combustion chambers this material pairing offers the possibility of combining the thermal conductivity of copper with the thermal fatigue properties and high-temperature resistance of cobalt alloys (Liu et al., 2025). The possibility to combine a metal like gold, which is - similarly to copper - highly electrically and thermally conductive with a more mechanically resilient copper alloy by the means of PBF-LB/M is also explored (Chen et al., 2023). It must be noted that the publication dates of studies concerned with materials other than steel are notably younger than studies which aim to combine copper with steel exclusively.

3.3 Hybrid manufacturing

In two studies, additive and conventional subtractive manufacturing processes are combined. One approach uses a machined copper substrate on which a maraging steel part was manufactured upon. Testing of the interfacial bonding strength revealed a specimen separation inside the copper part, without fracture at the interface, hinting at a satisfactory bonding (Tan et al., 2018). Another study revealed low bonding strength between materials like CuCrZr and 316L (Cortis et al., 2025). These studies are examples of the term *hybrid manufacturing* used to describe the combination of additive and subtractive processes. The differentiation to post-processing, which usually employs conventional processes, can be difficult or ambiguous. Using sintering techniques or hot isostatic pressing in unity with or after AM fits technically the definition of combining AM with a conventional process, but in the analyzed cases the authors did not designate the method as such. Additionally, it was aimed at enhancing quality aspects of the parts produced, rather than enhancing functionality (Bernet et al., 2025; Deillon et al., 2024). Beyond the studies researching PBF-LB/M considered, additional meanings of *hybrid manufacturing* can be found in studies researching DED. This concerns a study which combined PBF-LB/M and BJ for the processing of copper and 316L, where copper is applied via an ink solution and is solidified with several laser passes, before 316L is applied and fused (Lee et al., 2024). The process effectively causes in-situ alloying and consequently enhances a material with higher functional properties like higher thermal conductivity but diminished mechanical properties in terms of microhardness. Describing the application of blue and infrared type lasers in DED for processing copper and a steel grade is another application of the term *hybrid manufacturing*, which again introduces a new meaning by addressing the usage of two different laser types in a single AM process (Wei et al., 2024). After analysis of the PBF research considered and additional processes beyond the original scope of this study like combined PBF-LB/M and BJ or multi-laser PBF, it can be concluded that the term of hybrid manufacturing does not have a consistent definition which is used by researchers in the field of multi-material AM with copper.

3.4 Processing strategies for multi-material PBF-LB/M

Apart from the joining of dissimilar materials with a sudden change in chemical composition at the interface, the continuous adjustment of the material is explored in several studies (Walker et al., 2022; Zou et al., 2025). The motivation varies between providing a tailored profile of properties in the interface to mitigate risks like solidification cracks or the formation of intermetallic compounds (Di Wang et al., 2021; Liu et al., 2025; Liu et al., 2024; Rankouhi et al., 2021; Schmidt et al., 2023). The in process alloying is another similar manufacturing technique, although this does not necessarily aim at the creation of a graded material (Sun et al., 2021). Post-processing and process engineering are alternative subjects of studies, aimed to address specific issues and properties of multi-material AM with copper (Chen et al., 2024a; Chen et al., 2024b; Mao et al., 2024; Meyer et al., 2025). The adjustment of the laser beam properties like the intensity profile influences the formation of interface defects and can further enhance the potential of PBF/LB-M to process dissimilar material combinations (Martendal et al., 2024; Uhlmann and Saber, 2025). The potentials of utilizing specific material properties in one part while simultaneously making use of design freedoms of AM is an often stated motivation in the analyzed research of PBF-LB/M (Chen et al., 2019). Challenges like cracking or demixing are not played down but addressed by focused studies (Bi et al., 2025; Martendal et al., 2025; Özsoy et al., 2025b; Özsoy et al., 2025a; Pellin et al., 2025; Wang et al., 2024). It is paramount for the successful application of multi-material parts that the interface between materials and part sections (Wang et al., 2025). Specific issues in interfacial boundaries, for example between CuSn10 and Inconel 718 are the shrinkage of copper-rich films during solidification (Iams et al., 2023) and the formation of the mechanically detrimental brittle intermetallic Laves phase C14-(Cr, Ni, Fe)₂Nb during DED (Preis et al., 2024). High heat dissipation of copper is another problem which can lead to insufficient melting (Iams et al., 2023). The available research hints towards a higher susceptibility of DED processes for these metallurgical defects, possible due to the thermal history and high heat input. Omitting the utilization of certain alloying elements can enhance the bonding strength, while simultaneously reducing favorable material properties (Wang et al., 2025). Interfacial cracking is not limited to nickel-copper interfaces. Solidification cracking at 316L and CuSn10 interfaces can occur and studies indicate that a specific copper content in mixing zones of approximately 10 % lead to increased solidification cracking (Wang et al., 2024). The vastly different solidification ranges of Cu- and Fe-rich liquids, which form in a wide variety of compositions are problematic (Özsoy et al., 2025b). Cracking is the consequence of the additional occurrence of thermal stresses during solidification which leads to a separation of the material at the liquid interfaces, mostly grain boundaries (Özsoy et al.,

2025a). These problems can be addressed through tailoring the melting mode, creating shallow melt-pools at the interface, limiting the mixing of materials and reducing the probability of cracks (Martendal et al., 2025). Besides investigations addressing defects through tailored process strategies, post-processing techniques aimed at interface defects like pores and cracks are developed. Hot isostatic pressing can be effective for achieving a higher part and interface quality, but comes at the cost of an additional process step (Deillon et al., 2024). With research hinting at the existence of feasible processing regimes and usable counteracting effects against crack formation, like control of interface mixing and producing a fine grained microstructure at the interface, the feasibility of additional process steps is limited (Bi et al., 2025). Problems related to the feasibility of multi-material AM in terms of the productivity and sustainability, like the mixing of the used powders, can be managed through system adaptations for multi-material AM (Bareth et al., 2023).

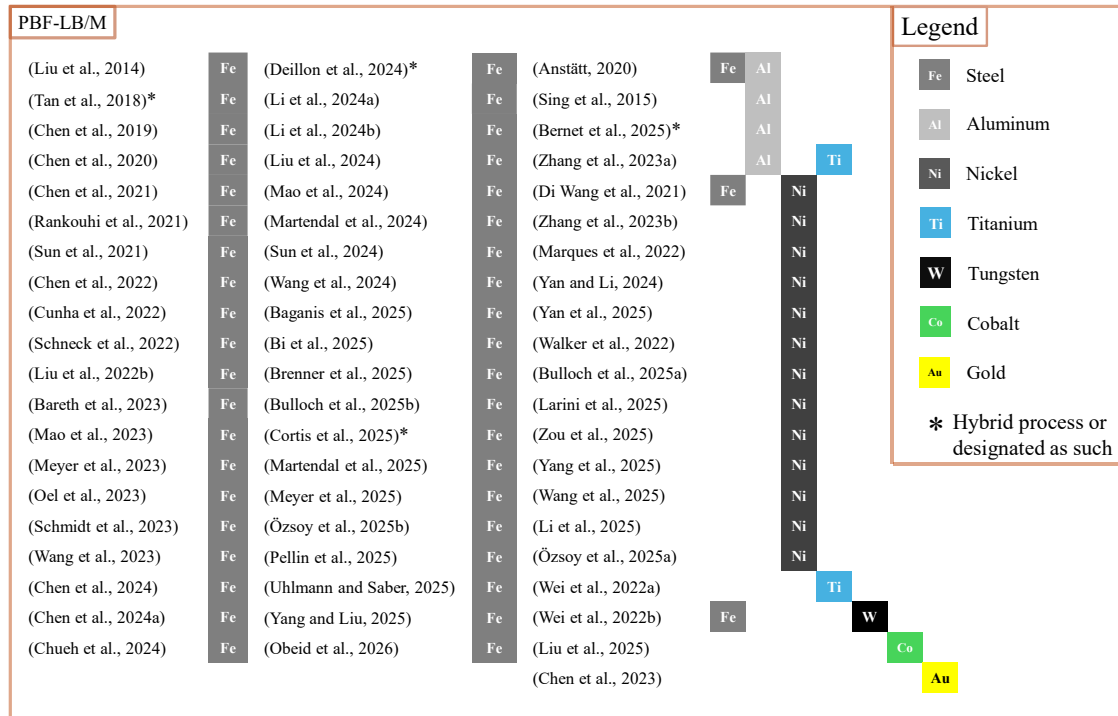


Figure 4. Overview of the researched literature, organized based on processed materials

3.5 Application case studies

The implementation of specific applications of multi-material AM with copper is presented in the literature, despite the challenges faced during multi-material AM. Steel 420 and copper are also combined for a similar application (Cunha et al., 2022). To reduce costs and possibly enhance the performance of a linear particle accelerator, researchers used the alloy CuCr1Zr and the tool steel 1.2709 in combination in one part (Brenner et al., 2025). 1.2709 and the copper alloy CW106C were also used to manufacture a combustion nozzle (Schneck et al., 2022). Stator coils in electrical machines offer the possibility of an enhanced power density by integrating water cooling. For this purpose, 316L and CuCr1Zr were combined (Oel et al., 2023). While the studies describe possible problems, mainly connected to material defects, they underline technology's maturity and potential, especially for high-tech applications, for example in space engines (Marques et al., 2022). Methodological approaches for the systematic use of multi-material copper AM are being developed in parallel with the more widespread use of this technology (Meyer et al., 2023).

The research analyzed in this study shows a clear focus on the utilization of PBF for the combined manufacturing of multi-material copper parts. 316L steel and nickel alloys are commonly used, together with CuSn10 or CuCrZr. This defines a research gap in less widely studied titanium and aluminum alloys together with copper alloys like CuNi2SiCr. These highly dissimilar alloys pose a challenge for direct fusion with copper-based alloys, which are analyzed often but not solved yet. In addition, the use of materials in combination with copper is considered, but the combination and production of specific material states is rarely brought forward. While the characterization of boundary layers is a common research goal, the effects on overall components or their application due to the formation of a thermally influenced boundary zone in multi-material AM are rarely examined. The postulated potential of combining copper AM with cast, forged, or otherwise specific material state substrate components can only be realized if these are not overly altered by thermally induced changes especially in the boundary layer.

4 Proposal for a Hybrid Manufacturing Approach

Derived from the findings in Section 3 the utilization of PBF-LB/M for manufacturing multi-material parts can be evaluated as possible, while facing technical challenges. PBF-LB/M is utilized in conjunction with conventional processes but not all conceivable degrees of freedom for advanced manufacturing of multi-material parts with tailored properties are exploited. Approaches from research in Section 3 include powder based manufacturing and mixing of materials or designating the manufacturing on a substrate plate as multi-material manufacturing (Baganis et al., 2025; Bi et al., 2025). These approaches show limitations like the necessity to have all used materials available as powder or that parts exhibit a microstructure which corresponds to PBF-LB/M (Sing et al., 2015). Desired metallurgical effects that can only be achieved through other manufacturing processes, such as casting or forging, cannot be replicated. The metallurgical effects of conventional manufacturing processes can be combined with the unique characteristics of PBF-LB/M. Starting from a flat parting line, a monolithic component can be built up using a conventionally manufactured substrate. Authors have manufactured substrate plates specifically for individual machines, which allow for the fixing and manufacturing onto conventionally manufactured substrates. An example for this was developed by Cortis et al., who manufactured 2D multi-material joints, utilizing a custom-made building platform made from brass (Cortis et al., 2025). Based on approaches like this, the idea is consequently developed further and aimed to be combined with effects of PBF-LB/M manufacturing.

The long-term goal is to use the manufacturing method presented below in a PBF-LB/M system with a laser in the green light spectrum to process copper and copper alloys and use conventionally manufactured components made of a wide variety of metallic materials as substrates. Green laser utilization serves the purpose of making use of the higher energy absorption of copper for green laser light, which is motivated by the higher process efficiency, processing in the heat conduction mode, facilitating the achievement of consistent results, and comparably smooth surfaces (Vahedi Nemani et al., 2024). Combining additive and conventional manufacturing processes into a hybrid process extends on the utilization of process-inherent effects. For example, achieving precipitation effects in materials like copper alloy CuNi2SiCr through the cyclic heat input during PBF-LB/M. It is found that the in-situ precipitation is possible and influenced by the temperature history, which is determined by process parameters governing the thermal energy input (Mohebbi et al., 2024). For copper alloys, research is currently focused on achieving a sufficient part quality, without in-situ tailoring of properties (Fereiduni et al., 2025). Adapted processing strategies for an increased heat input should enhance precipitation hardening to a technologically interesting level. Inside the processing regime, laser power can be increased or laser scanning speed decreased to increase the energy input. The exposure of part sections can be repeated multiple times. As changes in the melt-pool morphology are possible and the process might transition between the heat-conduction or keyhole mode, simultaneous changes in the laser spot size can be utilized to adjust for higher energy densities and controlling unwanted side-effects like splattering or keyhole pores. Adjusting pre-heating temperatures can be used for precipitation hardening, but may also influence the substrate part, which does make this approach not always feasible. The in-situ precipitation hardening aims to make separate heat treatment during post-processing obsolete and reduce the risk of distortion. Parameter adjustments must be tuned to avoid defects, which is going to be challenging considering the interdependence between thermal energy input and the resulting microstructure of metallic components.

In addition to influencing material properties and the design freedom inherent in AM, there is further potential in the creation of non-deterministic porous structures and surfaces. Chemical and electrochemical processes benefit from electrodes made of highly conductive copper, which have an adjustable relative density and an open-pored structure, making them superior to conventional components in terms of design flexibility (Guddati et al., 2019). For applications in corrosive environments and under demanding thermal loads, the combination with corrosion and temperature resistant materials as established in available research could enhance the functionality of porous parts further.

The design of the proposal for a multifunctional holding plate is based on welding tables, which allow the clamping of components of different shapes and sizes with repositionable brackets. Figure 5 illustrates a sample holder, as well as the multifunctional holding plate in its final design. All plates are tailored to a *AconityMIDI* PBF system by *Aconity3D GmbH*, Germany. Their functional principle is transferable to any other machine which uses substrate plates. Figure 5 (A) shows substrate materials that can be used for testing, illustrating the consistent combination of copper-based precipitation hardening alloys such as CuNi2SiCr with other high-performance materials. The multifunctional holder and sample holder have a diameter of 170 mm and are manufactured from a stainless-steel grade. To facilitate substrate positioning and the alignment of digital models in the PBF system, the holding plate is outfitted with 1 mm deep grid and circular grooves. The positioning of the manufacturing model is supported by digital templates, based on the position and geometry of the substrate, indicating the necessary model position in the machine control. This avoids misplacements and consequently possibly insufficient part overlapping and bonding strength. Components are clamped in place using movable fasteners. These have a threaded hole in the direction of assembly. These elements are screwed into the mounting plate using grub screws. The grub screws can be screwed in so far that they no longer protrude beyond the mountings. This reduces the minimum height required for a substrate to create a surface that can be coated with powder. However, this can be reduced further by adjusting the height of the mountings. Tension in the components is created by the mutual support of the holders against the component and their screwing in. The forces involved are negligible, as the necessary holding forces are also low. In Figure 5 (C) a microwave horn antenna is shown as an example for a conventionally separated assembly, which

profits from a monolithic design, incorporating different materials. For example, copper can be used in the antenna's corpus for a high signal quality, while reducing weight with a part manufactured from aluminum. Heat-exchanger, electrodes for corrosive environments in chemical processes, and induction coils are a selection of products which can be improved by the utilization of several materials, while combustion chambers or die casting mold inserts might even make use of tailored materials conditions regarding their mechanical properties after PBF-LB/M.

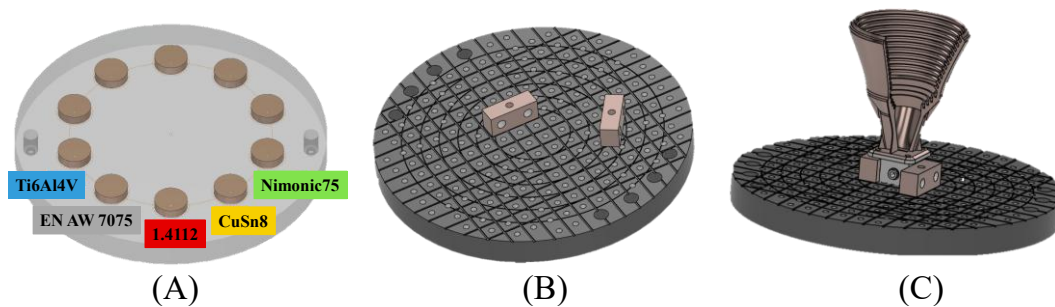


Figure 5. (A) A preliminary design for securing sample substrates for metallographic analysis (B) Multifunctional holder with two clamping devices (C) A demonstrator mounted on the multifunctional holder after manufacturing a horn antenna on a substrate

While technically and physically possible, the presented approach faces limitations, besides that the feasibility has yet to be demonstrated. Using PBF rather than DED, the separation of conventionally and additively manufactured part sections must be a flat surface parallel to the substrate plate surface of the machine. This limits the design freedom of the substrate used. As determined by this review and overall available research, defects caused by widely varying properties of the metallic joining partners for multi-material PBF are problematic, especially for commercially interesting combinations like copper and tungsten (Wang et al., 2026). Further investigations into processing techniques, surface conditioning, and metallurgical effects are vital before multi-material AM in general and multi-material PBF-LB/M can be utilized to their full potential.

5 Conclusions

The conclusions of this study findings are summarized as answers to the initial research questions and a summary of the manufacturing approach presented:

- Existing research does not provide an exact definition of hybrid manufacturing. The term is used to describe a combination of conventional and additive manufacturing processes but is also used with vastly different meanings.
- Current research of multi-material copper AM combines pure copper and copper alloys with a broad set of metallic materials like different steel grades, aluminum, titan, and nickel alloys. The research is motivated by the potential of achieving different properties in one monolithic part. The focus lies on characterizing the intermediate layer between copper and fused metallic materials and the mitigation of defects. Real-world applications for multi-material copper AM are available.
- A flexible mount for the utilization of common PBF systems for manufacturing multi-material parts is presented, developing existing approaches further. Existing research suggests that the idea described is feasible, although further experimental studies based on this study still need to be conducted.
- Together with process knowledge from PBF-LB/M of copper for the manufacturing of determined relative densities and fluid permeability and a concept for in-situ hardening of suitable alloys, this poses an approach for the realization of a broad variety of real-world application examples.

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