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Manufacturing and heat-treatment of Ti-6Al-4V hybrid parts by combining Laser Beam Melting and sheet metal forming

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Additive manufacturing (AM) technologies offer a high degree of design-freedom. The most important technique for AM of metals is Laser Beam Melting (LBM). The process facilitates the production of advanced products like weight optimized structures [1] or highly efficient fuel nozzels [2]. However, LBM is rather slow and expensive compared to conventional manufacturing technologies like sheet metal forming. By combining LBM and sheet metal forming the advantages of both processes can be exploited. This allows a cost- and resource- efficient manufacturing of the sheet metal body and a functionalization and individualization of the same by additively manufactured elements. For manufacturing of such hybrid-parts two process-routes comprising AM prior to forming and AM after forming are conceivable (Figure 1). The general feasibility of this approach has already been demonstrated in previous work [3]. Within this work the effect of different heat-treatment strategies on the resulting microstructure of the Ti-6Al-4V hybrid-parts is investigated, as this determines the mechanical properties. Following LBM a predominantly α'-martensitic microstructure is present in the LBM-element, while the sheet metal body still consists of a globular α/β-microstructure [4]. After a heat-treatment at 850°C for 2 h, which was derived from Vrancken et al. [5] the α'-martensite is dissolved into an acicular α/β-microstructure (462 HV0.05) showing a reduced hardness of 387±14 HV0.05 compared to the α'-martensitic microstructure. This decrease in hardness presumably goes along with an increased formability. However, the microstructure of the LBM-element is still harder than the globular α/β-microstructure of the sheet metal body with 324 HV0.05. A heat-treatment for 2 h at 1050 °C and hence above the β-transus-temperature leads to an homogenization of the microstructure and the hardness differences throughout the hybrid-part are dissolved due to the occurring phase transitions [6]. The variation of the heat-treatment strategy therefore allows the production of parts with homogeneous material properties but also with different material properties in the sheet metal body and the LBM-element. This offers an additional degree of freedom for designing optimized, high performance parts with tailored material properties.

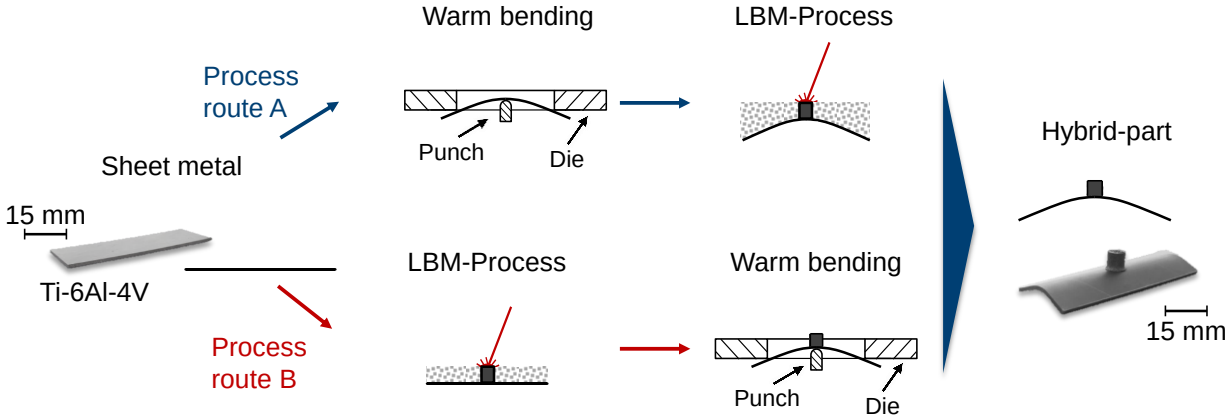

Figure 1 : *Process routes for manufacturing of hybrid parts by combining LBM and sheet metal forming*

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