Investigation of Microstructure of a Rib Geometry Produced by Metal Forming and Additive Manufacturing

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Abstract. The high-performance parts are traditionally produced by hot forging and require expensive dies. Besides, to obtain net shape parts, extensive machining operations are used which may entail a material yield of less than 10 %. For many applications, net-shape technologies such as additive manufacturing (AM) could enable a more resource-efficient production. However, manufacturing costs and process time in additive manufacturing rise rapidly with the part size. Thus, the disadvantages of AM and forging operations could be levered by mating both processes to new process chains, allowing to reduce the number of processing steps and to avoid high material waste. Innovative process chains combining these two manufacturing techniques have been put forward recently, but almost no scientific knowledge on such processing route exists. Most of the existing work focusses on AM of features on pre-formed sheet metal parts. The present study investigates the use of additive manufacturing for generating or modifying stiffening ribs on pre-forms created by hot forging. First, a semi-finished product containing a rib geometry is produced under typical hot working conditions, and the rib height is increased by AM. The interface and microstructures induced by AM and their role on mechanical properties are analyzed. AM induces repeated heat inputs with high cooling rates and promotes formation of the specific microstructures. It can be shown that the proposed processing route appears to allow for similar properties as conventional forging process chains, but may reduce the number of processing steps and increase the material yield.

Forging, Additive Manufacturing, Microstructure.