Additive Tooling for Thermoforming a Bonnet of an UAV Using Binder Jetting

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Abstract. The fast and cost-effective manufacturing of tools for thermoforming is an essential requirement to shorten the development time of products. Thus, additive processes are used increasingly in tooling for thermoforming of plastic sheets. However, a disadvantage of many additive methods, e.g. the laser melting, are highly cost-intensive, since complex systems based on laser technology and expensive metal powders are needed. Therefore, this paper examines how to work with favorable additive methods, e.g. Binder Jetting, to manufacture tools, which provide sufficient strength for thermoforming. The use of comparatively low-priced inkjet technology for the layer construction and a polymer plaster as material can be expected to result in significant cost reductions. Based on a case study using an engine bonnet for an Unmanned Aerial Vehicle (UAV), the development of a complex tool for thermoforming is demonstrated. The object in this study is to produce a tool for a complex-shaped component in small numbers and high quality in a short time and at reasonable costs. Within the tooling process, integrated vacuum channels are implemented in additive tooling without the need for additional post-processing (for example, drilling). In addition, special technical challenges, such as the demolding of undercuts or the parting of the tool are explained. All process steps from tool design to the use of the additively manufactured tool are analyzed. Based on the manufacturing of a small series of engine bonnets for a UAV made of plastic sheets (ABS), it is shown, that the Binder Jetting offers sufficient mechanical and thermal strength for additive tooling. In addition, an economic evaluation of the tool manufacturing and a detailed consideration of the required manufacturing times for the different process steps are carried out. Finally, a comparison is made with conventional and alternative additive methods of tooling.