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Abstract

Indirect additive manufacturing for patient-specific, highly complex medical devices

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Additive manufacturing enables the efficient production of highly complex components. In binder jetting, particle material is bonded in layers by selectively applying binder on particle layers. With this technique molds for metal casting, which can be applied in medical technology, can be produced in a cost-efficient way. The molds can be easily adapted, which is particularly interesting for patient-specific implants. In the work presented, the stack casting and slurry-based binder jetting methods for the production of orthoses and joint implants will be discussed.

An option for using indirect additive manufacturing in medical technology is stack casting, which can be used to produce larger, highly complex, and individualized components for orthoses, for example. Here, the casting mold is made up of multiple mold pieces instead of two or very few mold parts, as is traditionally used. As the individual casting mold pieces are cleaned of loose sand before assembly, it is possible to achieve a higher design complexity and simplified automatization of cleaning [1]. The additional degrees of freedom provided by additive manufacturing enable new possibilities in the design of orthoses, which can lead to better handling for the patient.

For more precise cast parts restrictive parameters such as surface roughness or mechanical stability can be improved by using slurry instead of powder, in the so-called slurry-based binder jetting [2]. Compared to sand binder jetting, it is possible to reduce surface roughness by up to 90% with slurry-based binder jetting [3]. Furthermore, it is feasible to vary and optimize the microstructure of the implant, by adjusting the wall thicknesses of the cast and the casting mold. This could lead to improved performance of the implant and with this to better durability. Slurry-based binder jetting has the potential to produce mechanically stable, complex, and delicate molds for investment casting. Compared to traditional investment casting, the cast production needs fewer manufacturing steps and designs can be changed easily. For this, using additive manufacturing for investment casting, a more efficient way of producing investment casting components such as knee, hip, and finger joint implants can be realized.

In future projects, material systems and process parameters for the production of investment casting shells for the manufacture of medical devices are to be determined to enable the flexible, time-efficent and sustainable production of patient-specific medical devices with fewer process steps.

AUTHOR'S STATEMENT

Conflict of interest: Authors state no conflict of interest. Informed consent has been obtained from all individuals included in this study.

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