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Porosity in CoCr components as a function of energy density

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Abstract

Selective Laser Melting (SLM) brings the ability to build parts of high geometric complexity with the opportunity for cost-effective individual and customized part production. An important area of application for the SLM process is the production of removable partial denture frames.
Sufficient strength is essential for the long life of the denture. This can be reduced by high porosity and become a problem during chewing movements and daily insertion of the frames.

The aim of the investigation is to achieve a high density of over 99 % with the shortest process time for a simplified geometry of removable partial dentures from CoCr. At the same time, it is important to avoid cavities in the component caused by balling or keyholing phenomena, which occur when there is not enough or too much penetration of the laser when melting the metal powder. To address this, a parameter study was carried out to determine the optimum process parameters in the machine-material combination of an Orlas Creator and CoCr-Alloy powder. The study focused on parameters that affect the energy density, such as scanning speed and laser power. Using a CT scanner, it was possible to image the internal structure of sample bodies and efficiently determine the porosity in the printed parts. An examination of the microstructure with an optical microscope was carried out after cutting, polishing, and etching. Depending on the process parameters, balling or keyholing was detected and thus the possible combination of process parameters was further defined. The process window for high density parts was identified in this way as the starting point for further parameter studies, in relation to the strength of the parts.

Figure 1 Removable Partial Dentures on the build platform after printing