



Medical applications of Rapid Manufacturing

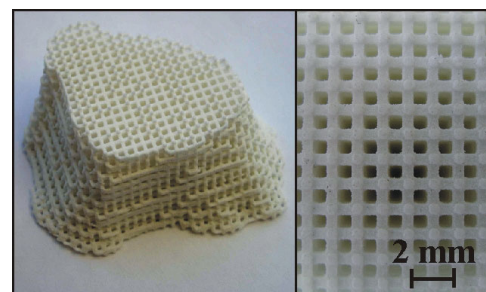
In recent years, digitizing and automation have gained an important place in the manufacturing of medical or dental products. However, many prostheses are still being produced by manual and lengthy conventional methods. This research aims at a digital fabrication of complex medical and dental prostheses by means of Selective Laser Sintering (SLS) or Selective Laser Melting (SLM). Due to technical improvements, these techniques are no longer exclusively used for prototyping and the possibility to process all kind of metals yields opportunities to manufacture real functional parts. Medical and dental applications could take advantage of this evolution by using SLS/SLM not only for plastic devices like visual anatomical models or one-time surgical guides, but also for functional prostheses with long-term consistency made from a biocompatible material.

Medical and dental applications are very suitable for processing by means of Rapid Manufacturing processes due to their complex geometry, low volume and strong individualization. The manufacturing of multiple unique parts in a single production run enables mass customization. Due to the layer-wise production of SLS/SLM, a complex shape can be built with minimum manual intervention and without lengthy post-processing. Mostly, prostheses are made from titanium-alloys because these light metals combine good mechanical and biocompatible properties. Cobalt-chromium-alloys are frequently used for dental products. Degradable biopolymers are used for structures replacing bone material. In contrast to removal techniques like milling, for which most of the expensive material is wasted, unprocessed powder can be reused for SLS/SLM.

This research tries on the one hand to optimize the processing of biocompatible materials by SLS/SLM and on the other hand to apply this knowledge for some realistic case-studies. A digital procedure is developed for the production of implant-supported frameworks for complex dental prostheses by means of SLM of a titanium-alloy (Ti6Al4V) or a dental cobalt-chromium-alloy. Offering a digital solution to the dental profession implies a real challenge because patient and dentist set high requirements on quality, material and precision. Personalized frameworks are manufactured with good mechanical properties and with a medically acceptable accuracy. Next to this dental application, the production of scaffolds by means of SLS of a polymer is studied. Scaffolds are porous structures for large bone defects which allow injected bone cells to develop into new bone material. The complex internal structure of the scaffold can be produced in a fully controlled way by SLS, so that optimal pore dimensions can be obtained.



Dental framework manufactured by SLM of Ti6Al4V.



Scaffold manufactured by SLS of PA.