

# LITHOGRAPHY-BASED CERAMIC MANUFACTURING IN DIGITAL DENTISTRY

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Additive Manufacturing (AM) is a summarizing term for a quantity of technologies that enable the processing of metals, plastics or ceramics. They all have in common, that they generate physical 3-dimensional objects layer by layer. AM technologies are especially useful where small and complex parts are needed in small numbers. One of the fields that could benefit from this technological advance is the biomedical field, due to its high demand for individualization, when it comes to implants for example.

The demand for individualization is especially big in the dental industry, where aesthetic considerations like color and translucency are adding to the need for a specialized shape. To enable a successful restoration, like a crown or bridge, high precision and good surface quality are key factors.

Stereolithography is an AM method that excels in these categories and therefore is suitable for dental applications. This technology uses either LASER or Digital Light Processing (DLP) to induce finely localized photopolymerisation in a photoactive resin, as the layer generating mechanism. Fig. 1 shows a schematic setup of the DLP-based stereolithography machine used in this work. It is state of the art to use stereolithographic machines to produce models and molds from polymeric materials.

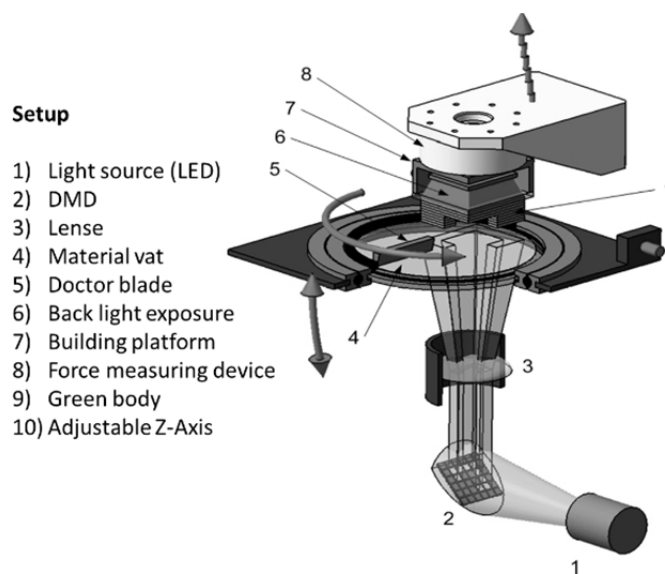


Figure 1: Schematic setup of the DLP machine at TU Wien

This work focuses on the production of full ceramic restorations by Lithography-based Ceramic Manufacturing (LCM). To achieve this, instead of a resin, a photoactive suspension is used and a thermal post-processing step (debinding and sintering) is performed after the printing process itself. Fig. 2 shows two glass-ceramic biaxial bending test plates produced by LCM. Translucency is a highly desired property in dentistry.



Figure 2: Translucent glass-ceramic test plates produced by LCM

The chemical and technological optimization of the LCM process is the main topic of this work. Beginning with the formulation of the suspension and its process relevant properties like rheology, to technological dependencies like construction and material choice of the coating mechanism, to post-processing issues like debinding schedules and final material properties like bending strength, all relevant steps of the process chain are discussed and analyzed. For this, a variety of analytical instruments are used, among them rheometry, thermogravimetry (TGA), thermo-mechanical analysis (TMA), scanning electron microscopy (SEM) and Weibull analysis. Fig. 3 shows an SEM image of the fracture surface of a biaxial bending test plate. No porosity is visible, which indicates densities close to the theoretical maximum.

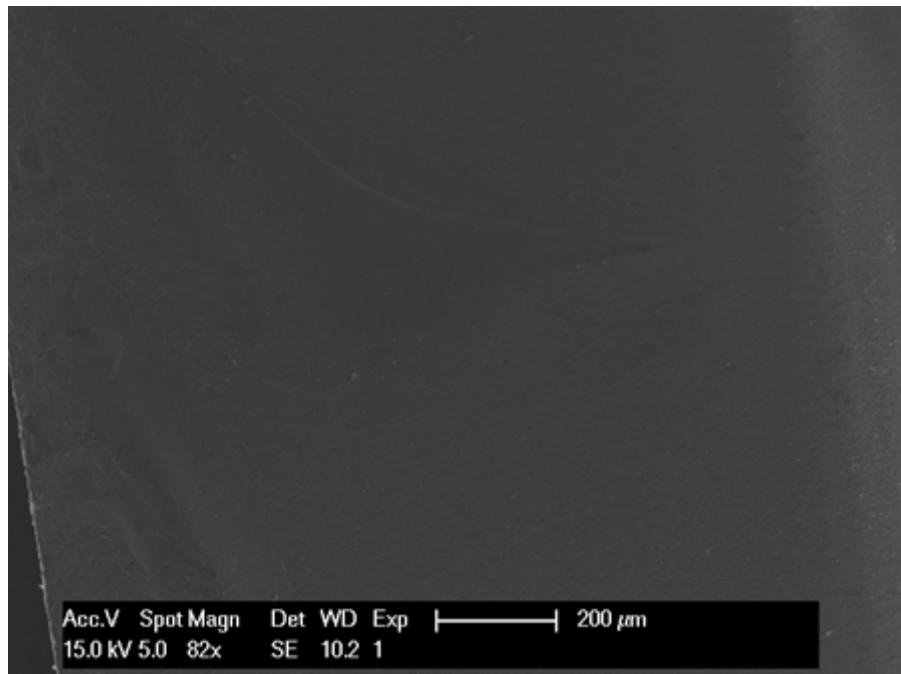


Figure 3: SEM image of the fracture surface of a glass-ceramic test plate