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Effect of materials properties in 3D product geometry during stereolithography

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The 3D printing of parts using stereolithography (SLA) consists of making use of a photocurable liquid resin in combination with a layer-by-layer manufacturing process in order to materialize the digital design of an object [1]. SLA technology has several features, of which it is worth mentioning the potential for printing complex shapes with high resolution. Additionally the type of resins utilized in SLA is made of a mixture of different components [2]. In a simple recipe we found at least three components namely the reacting monomer, photoinitiator and dye. It is clear that the final properties of the printed object will be dependent upon the concentration of the components in this recipe, but also on the process conditions. In the modeling of SLA the link between the process and materials settings is often overlooked. Typical questions such as: does it help in reducing internal stresses to have a heat sink or a heat insulator as mounting plate? or, what is the relative change in the final warpage of an object when the concentration of the dye changes? are often left unanswered. In this work we present a simulation framework that combines the SLA printing process together with a material model of the resin including its kinetic, thermal and mechanical behavior. By using such framework we can vary either the material or process parameters in order to estimate what their influences would be in the final quality of a printed object. The object in question is a simply-supported square plate formed by the addition of subsequent number of layers. We first look into the effects of the inhomogeneity and the geometrical-nonlinearity on the resulting stresses and strains in the printed object. Secondly, we pay attention to the final warpage obtained along the object when resin properties, such as the dye concentration or the reaction rate for radical formation, are changed and how it depends upon the number of layers printed. Currently we are working towards validation of the framework utilizing experimental data on printed test samples. We also will discuss how such validation could be carried out using the information gathered commonly for the calibration of the optimal printing and material parameters.

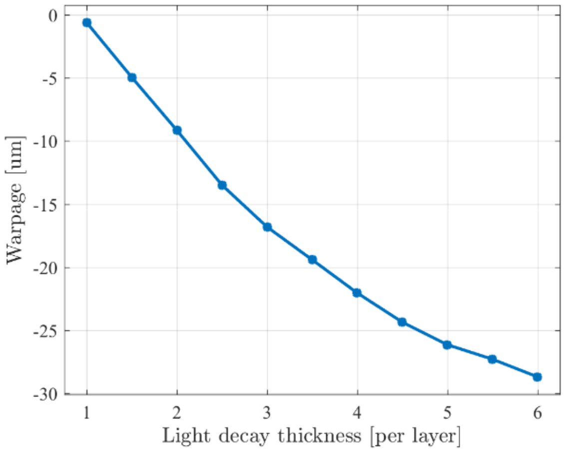

Figure 1 The final warpage of 3D printed plates with different concentrations of the dye, which influences the light decay thickness.

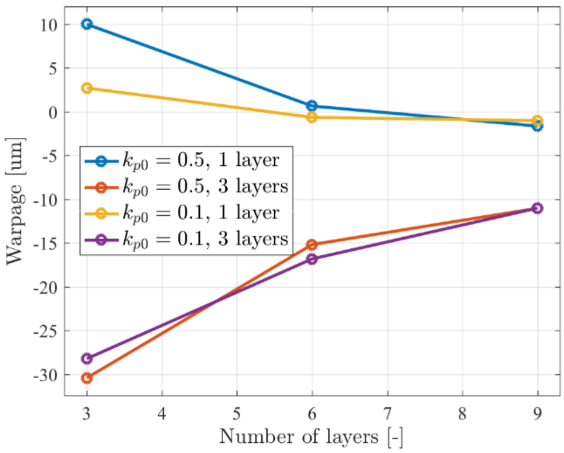

Figure 2 The resulting warpage of 3D printed plates when material is tuned to different reaction rates.

References

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