INVESTIGATION OF THE POTENTIAL OF NEW MATERIALS IN DLP

Current developments in the field of materials create new potential for the use of the additive manufacturing process Digital Light Processing (DLP) or similar processes on the basis of vat-photopolymerization. Previously existing weak points, such as brittle components or low UV resistance, are no longer present due to the new materials. Therefore, the suitability of this process for manufacturing end products is increasing. Many new opportunities are emerging, which create a great need for research in this area. For this reason, the DMRC starts with the research of the DLP process and the material properties.

PROJECT OVERVIEW

DURATION

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PARTNER

Industrial Consortium of DMRC

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Process description

In the DLP process a resin is cured layer by layer using UV light. That way three-dimensional components are generated. The liquid resin is in a vat with a transparent film in the bottom (see figure 1). It consists of a mixture of monomers, oligomers and photoinitiators. When exposed with UV light, the photoinitiators trigger a polymerisation reaction and a crosslinked polymer is produced. The light source is a DLP projector. The resin is exposed to the light emitted by the projector from the bottom through the transparent film.

There are other additive manufacturing processes similar to the DLP that are also used to produce components by a vat-photopolymerization. The stereolithography (SLA) and the mask-stereolithography (MSLA) process are two examples for these. They differ in the light source. Most of the available materials can be used for all three mentioned processes.

The in the DLP process possible layer thicknesses are approx. 10 to 100 µm and are therefore lower than in most other additive processes, such as Laser Sintering (LS), Fused Deposition Modeling (FDM) and Arburg Plastic Freeforming (AKF). With the DLP process a very high surface quality and a high resolution of the parts can be achieved. These advantages in connection with new materials make the process interesting again for many industrial applications.

First impressions

The DLP Printer Loctite® EQ PR10.1 will be delivered to the DMRC in June. In order to get some impressions in advance there was the possibility to temporarily use a MSLA-printer for home applications for some tests. In the MSLA process there are LEDs which shine through an LCD Display instead of a projector as light source. The rest of the process and the post-processing is very similar to the DLP process.The first test revealed the advantages and the potential of the DLP process. The surfaces are very smooth and it is possible to build parts with many details and thin structures (see figure 2 and 3). Due to the small layer thickness, the stair-step-effect is almost non-existent. In addition to materials with high hardness, high impact strength or high temperature resistance, elastomers can also be printed using the DLP process, thus enabling the user to manufacture components with a high degree of flexibility. The first tests also show the importance of the post-processing. After the build process is finished any excess resin has to be removed from the part. Subsequently the part has to be cured with UV light. This has an influence on the mechanical properties, the dimensions and partly the color of the parts.

The tests have also shown some disadvantages of the process. Support structures are needed for nearly all parts. After removing the support structures little marks remain and the surface quality is reduced in this area. Up to now only materials of the previous generation have been tested. Based on this the printed parts were very brittle. In further investigation there are tests with the new and improved materials planed.

Investigations

The focus of the investigations is on the material properties. Due to the disadvantages of earlier materials (brittle fracture behavior, low UV resistance), which have been known for many years, the industry is partly skeptical about the DLP process. Therefore, there is a great need for research concerning the new materials in order to test the improved properties and to develop the new application possibilities.

In the experimental investigations, the material properties will be tested and material-specific differences in production will be determined. There is a large range of new DLP-Materials which should be tested. The determination of mechanical properties according to DIN EN ISO 527 and DIN 53504 is important. It is planned to determine the influence of the orientations (X and Z), of the exposure parameters during production and of the subsequent UV exposure on the mechanical properties. Because dimensional accuracy is essential, especially in the manufacturing of end components, this is also examined in more detail. In the tests, the influences of specimen orientation, process duration and finishing on the dimensional accuracy are examined.

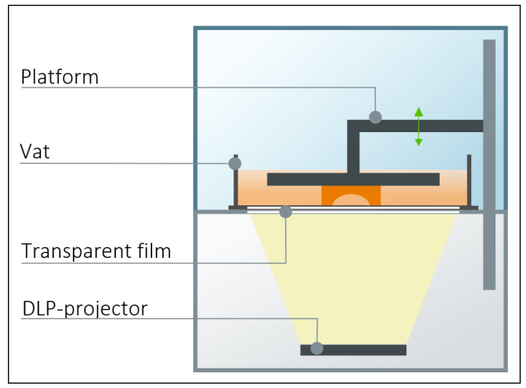

FIGURE 1 DLP-Printer

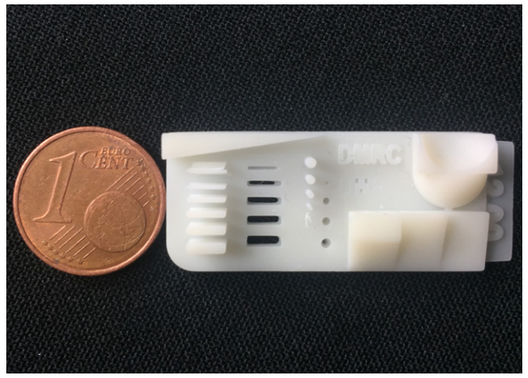

FIGURE 2 Example component 1

FIGURE 2 Example component 2