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Surface Treatment Methods for FDM Parts

Fused Deposition Modeling (FDM) parts show rough and wavy surfaces with stair step effects at slopes and round part geometries. For the application of this parts, especially for end use products, the surface has to be treated primarily for decorative aspects or/and in order to achieve water tightness. The surface treatment includes a surface smoothing first and a subsequent coating or a coating that generates smooth surfaces. An important criterion for possible finishing methods is to keep the flexibility of the additive manufacturing process.

Surface quality

Characterization of the surface quality by measurement of the surface profile

The characterization of the surface quality will be done with a mechanical contact profilometer by measurement of the average height of profile, R_z . Figure 1 shows the R_z values for FDM Ultem*9085 part surfaces produced with different build angles.

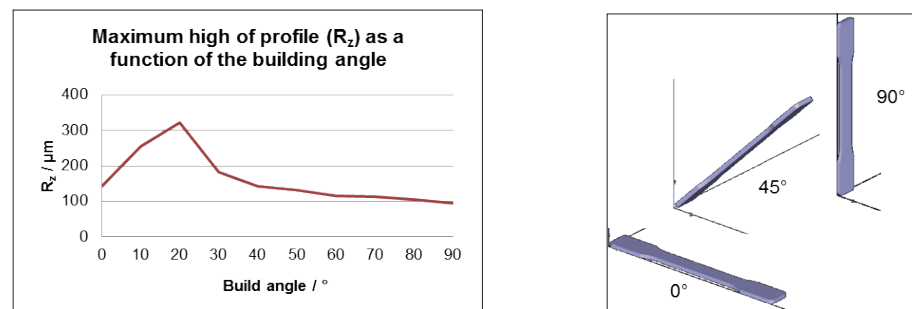


Figure 1: a) Maximum height of the profile of FDM parts; b) Tensile specimens in different building angles

The measurement of untreated FDM parts show the dependence of the surface quality over the build angle. For parts with small build angles $>0^\circ$ the average height of profile is much higher than for 0° or 90° build orientations. By using the Insight Software function "Visible Surface Style: Enhanced" smaller filament width and negative filament air gaps at the part surface can be generated. This results a better surface quality for 0° build angles.

Analysis of the finishing efficiency of the mass finishing process on parts build up with Ultem*9085

Surface smoothing by mass finishing

The advantage of a mass finishing process is the high flexibility and productivity. In this project the process is conducted on a disc finishing unit from the Eco 18 series, produced by OTEC Präzisionsfinish GmbH. In different experimental series the finishing efficiency of the disc finishing process was ana-

lyzed by changing the finishing time, velocity and media. For mass finishing processes many finishing media with different sizes and material grade are available. Ceramic media show promising results for a post treatment of Ultem*9085 parts. Figure 2 shows an overview of some ceramic media, which were analyzed regarding their finishing efficiency.



Figure 2: Ceramic finishing media

The finishing media are separated in different groups of abrasives by the producer. Besides to the standard abrasive media also polishing media are available. The influence of the disc finishing process parameters to the part surface is analyzed by using different specimen types in order to replicate different part geometries of the application. Especially the finishing of grooves and interior part surfaces show challenges. In certain cases the finishing process results an additional material erosion of corners and edges, which is shown in figure 3 by a 3D scan.

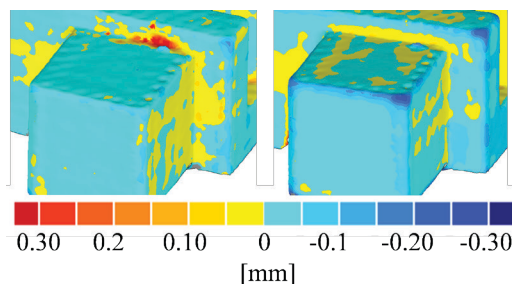


Figure 3: Material erosion at corners and edges

Coating Methods

The FDM process causes gaps between the oval filaments. Removing the gaps by grinding the surface by a mass finishing process takes a lot of time and results an additional material erosion of corners and edges. Therefore a combination of coating and mass finishing was analyzed regarding the optimization of the surface quality. The using of different finishing media, time and velocities for uncoated and coated parts is just as important as the choice of a suitable filler. One of the advantages of the Ultem*9085 is the certification for aerospace application. For this reason, the filler should also fulfill the requirements for an application in the aerospace industry.

Application of coating technologies in order to generate smooth part surfaces

Resistance Analyses

The quality of the coating will be qualified by the adhesiveness on the Ultem*9085 part. In further investigations the resistance of the coating against environmental conditions will be carried out. Therefore, selected parts will be stored under defined conditions to determine the long-time behavior.

Analysis of the adhesiveness of the coating for different environmental conditions