Analysis of the FDM Part Quality Manufactured with ABS with the Focus on the Toy Industry


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The aim of this project is to establish a database that is necessary for the direct manufacturing of parts via the Fused Deposition Modeling in the toy industry with the material ABS. For this, not only the strength properties and the influencing parameters on the strengths have to be worked out, but a knowledge of possible surface finishing methods is also needed in order to create a component that meets the given requirements. Another very important topic is the dimensional accuracy of the parts. A very high fitting accuracy is necessary in some applications. This research project is divided into three work packages. First the mechanical strengths are analyzed, then the surface characteristics in combination with the dimensional accuracy of FDM components manufactured with the material ABS are investigated experimentally.

Mechanical Strength Properties

First, the mechanical strength properties of ABS parts will be analyzed according to the ISO standards for plastic materials. The tests to be conducted are shown in Figure 1. For the purpose of these tests, test specimens will be built up with different slice heights due to variation of the tip size. Furthermore, the build orientation will be varied. First, components will be built up with the preset toolpath parameters and then these parameters will be changed in order to analyze the effect of the inner part structures of the fabricated parts on the resulting strength properties. Additionally, some tests will be conducted according to the standards of the toy industry in order to work out possible application fields.

Surface treatment methods

In this work package, the analysis of surface characteristics for ABS parts will be conducted with the aim of improving the decorative surface properties. In general, FDM-parts show rough and wavy surfaces with stair-stepping effects whenever the parts have sloped or rounded geometries. Important FDM process related parameters for the surface characteristics include: layer thickness, filament width, air gap and build orientation of the component. The post

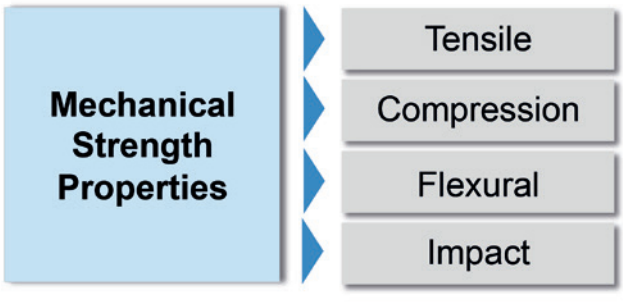

Figure 1: Mechanical properties

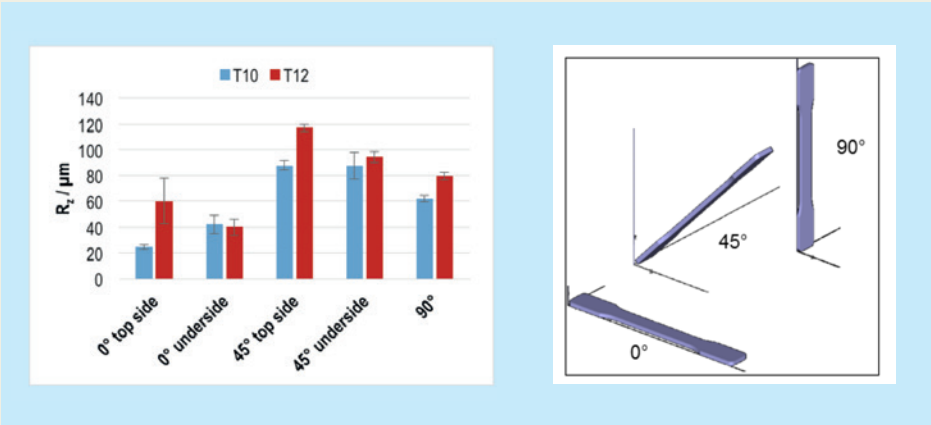

Figure 2: a) Average height of the profile of FDM parts; b) Tensile specimens in different building angles

treatment will be focused on mechanical methods such as vibratory grinding and abrasive blasting. For mass finishing, the process parameters granulate, geometry of the granulate, finishing time, and intensity will be analyzed. The influence of layer thickness, build orientation, and measurement direction on the surface roughness of untreated parts is shown in Figure 2.

Dimensional accuracy

Furthermore, the analysis of the dimensional accuracy of ABS parts will be conducted with regard to the surface smoothing method. To achieve this goal, standard elements were built with different process parameters (slice height, orientation and toolpath). The deviation from the nominal size is measured before and after a grinding treatment. Thus, the aim is to define a general guideline on how to achieve a required fitting accuracy in relation to the manufacturing process and the used surface smoothing method.

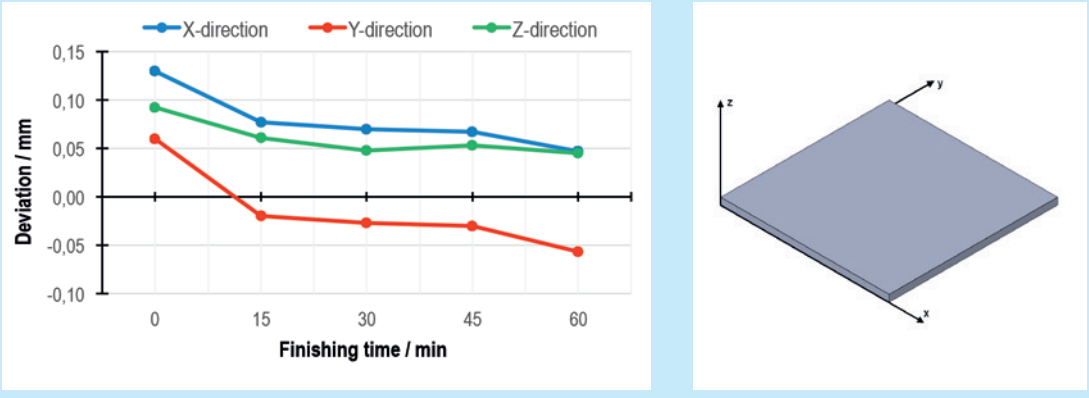

Figure 3: a) Dimensional accuracy of the standard element “plate” after grinding process; b) Standard element “plate” with the nominal size 50 x 50 x 2 mm (x/y/z).