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"POLYMERS FOR 3D PRINTED STRUCTURES, PRECISION, TOPOGRAPHY AND ROUGHNES"

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Abstract:

Three-dimensional (3D) printing is a new rapid additive method to make3Dobjectswith exact shapes and structures. 3D printing is being used for a variety of applications, including automotive, medical, dental, aerospace, consumer goods, toys, novelty items, embedded electronics and appliances. The goal of this work was to investigate the smoothness, precision and topography of plastic materials that can be used for three-dimensional printing applications. These three performance characteristics are crucial to performance of any 3D printed product. Fused Deposition Modeling (FDM) and PolyJet™ technology were used to produce 3D printed shapes for testing these performance measures for the different processes.

Three samples of acrylonitrile butadiene styrene (ABS) were printed utilizing different numbers of layers. That is, one, two and three layers at a 45º (head angle) were printed. The angle is related to the direction of the printing, which is controlled automatically by Maker Ware software of the 3D printer itself, without any external control from the operator or technician. Thickness and roughness for each sample were subsequently measured. One sample of polylactic acid (PLA) was printed with one layer at 45º and its thickness and roughness were also measured. Two other samples of ABS, having one and two layers, were printed at 90º then thickness and smoothness were measured. Polyvinyl alcohol (PVA) was printed with one layer at 45° and 90º. Digital ABS™ was printed at 6 different layer thicknesses. Thickness and roughness of printed 3D samples were measured using a White Light Interferometer.

The results show that the roughness of ABS at 45° and 90° increased with increasing thickness. The samples printed at 90° were smoother than at 45°, which means the orientation had a significant influence on roughness, but little on thickness. We found that the minimum thickness that Maker Bot can reach is 50 µm, while with Flash Forge it is 80 µm. The samples that were printed by Stratasys 500 Objet Connex3 were smoother

than those printed by Maker Bot replicator 2X and Flash Forge Creator Pro. Also, Stratasys 500 Objet Connex3 is more precise than either and it can reach thinner levels than either of them. However, the highest performance printer does not produce sufficient precision and smoothness for most 3D printing applications.

KEYWORDS

3D Printed Structures, Precision, Topography, Roughness.

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