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Post Processing of Parts Produced by Fused Deposition Modelling Process

P Vijendran[1] and Nara Sivabalaji[2]
[1-2]Madanapalle Institute of Technology& Science, Mechanical Engineering, Chittoor, India

***Abstract*—Fused Deposition Modelling (FDM) is one of the popular additive manufacturing technologies for producing parts with plastic material. It has been reported by various researchers that the surface roughness of the parts made by FDM process depends on pre-processing, build process, and post processing. Nine Specimens are built on FDM machine and the post processing of these specimens is carried out using acetone and emery paper of grade 120, 150, 220 and 320.It is found that polishing with emery paper has resulted in good surface finish compared to those processed by acetone.**

***Index Terms*— FDM, surface finish, Emery paper, Acetone.**

I. INTRODUCTION

Additive manufacturing is a layer by layer manufacturing process for producing parts with complex geometry in a short time. There are at least one dozen of the additive manufacturing technologies commercially available in the market. Fused deposition modelling is one such popular additive manufacturing process for producing parts using plastic material. It has been reported by several researchers that the surface roughness and dimensional accuracy of the parts produced by fused deposition modelling (FDM) depends on the pre-processing, building process and post-processing. In pre-processing the tessellation, part build orientation and layer thickness affects the accuracy and surface roughness. During build process, the process parameters such as nozzle dia, nozzle temperature, bed temperature, printing speed, affects the finish and accuracy. Post-processing parameters include the type of cleaning process employed such as treating with chemical or polishing with emery paper.

Pandey et al [1] improved the surface finish of FDM parts by using hot cutter machining. It is reported that he achieved the surface finish of Ra 0.3 µm with 87% confidence level using the hot cutter machining process. Mohammed Adel et al [2] used a navel low cost polishing technique where in a jet of hot air exiting from a nozzle is made to impinge on the surface of FDM parts. The stair-case on the surface is melted by the aid of hot air and leaves it smoother by the effect of sintering resulting in the reproducible improvements in surface roughness inherent with a glossy surface, whereas an average reduction ratio upto 88% was reached which corresponds to Ra of 0.85 µm. Vaibhav s.jadhav et al [3] used aluminium filled epoxy resin as a filler for improving the surface finish of the FDM parts. This technique has improved the surface finish and reduced the surface roughness of silicon rubber mold casting about 83 to 85 %. Percoco et al [4] investigated the effect of chemical treatment on the compressive strength and surface roughness of the FDM parts with a solution of 90% dimethyl ketone and 10% water. The author concluded that the proposed chemical

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treatments that can be used with immersion times upto 300 sec reduces the surface roughness upto 90%, improving mechanical properties in some cases better than those of non-treated parts. Shweta S. Dhoke et al [5] has reported that the surface roughness value is minimum at 90º build orientation and concluded that the surface roughness value increases as build orientation decreases.
The present work is focussed on building specimens on FDM machine and improving the surface finish of the parts by (a) polishing emery paper and (b) treatment with acetone.

II. EXPERIMENTATION

Rectangular specimens of size 30 X 20 X 10 mm were built on FDM machine using Acrylonitrile Butadiene Styrene material. Modelling of the specimens were made by using CATIA CAD/CAM software. The CAD model was converted to .stl format. The .stl model was sliced with a layer thickness of 0.1, 0.175 & 0.2 mm using CURA software. Three specimens were built for each layer thickness and totally 9 specimens are built. Fig.1 shows the photograph of specimens built on FDM machine. The build orientation was such that the 30 X 20 face of the specimen is made parallel to build direction.

Fig. 1: Specimens built on FDM Machine

The surface roughness of the parts was measured by using TALLY SURF surface roughness measuring instrument of make and model: Mitutoyo, SJ 210, and Japan.The cut-off length was taken as 10 mm .The surface roughness was measured on the surface which is parallel to Z-axis. Emery paper of grades 120, 150, 220 and 320 were used for polishing the specimens. The polishing time for each specimen was 10, 15 and 20 minutes for specimens with 0.1, 0175 and 0.2 mm layer thickness respectively. Thus three batches of specimens were produced. Totally 6 specimens, 2 from each batch were polished and the surface roughness of the polished specimens were measured. Acetone is used for polishing the remaining three specimens, one from each batch. Specimens were dipped into a beaker containing acetone for a period of 3 hours .The specimens were taken out from the beaker and the surface roughness was measured.

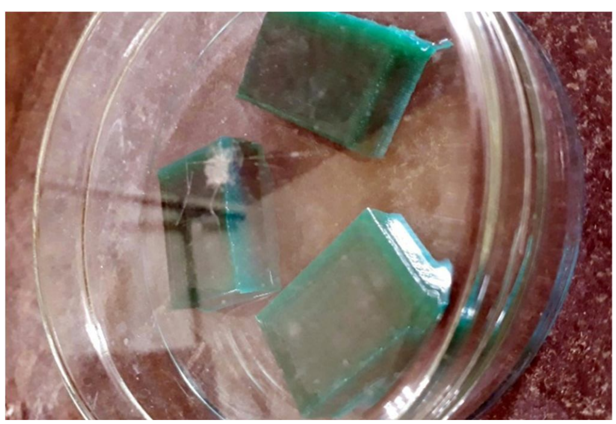

Fig .2: specimens in acetone vapour bath

III. RESULTS AND DISCUSSIONS

A. Surface roughness of as-built specimens.

Figure 1 shows the surface roughness of parts as-built by FDM process with layer thickness of 0.1, 0.175 and 0.2 mm. It is evident from the figure that the surface roughness increases with increase in layer thickness.

The increase in surface roughness with increase in layer thickness can be attributed to the increase in peaks and valleys of the surface as the layer thickness increases. This is in line with many researchers who have concluded that increase in layer thickness increases surface roughness value. [6].
Before post processing, the surface roughness of the parts are Ra 9.1795, 9.1075 and 13.5750 layer thickness of 0.1, 0.175 and 0.2 mm respectively.

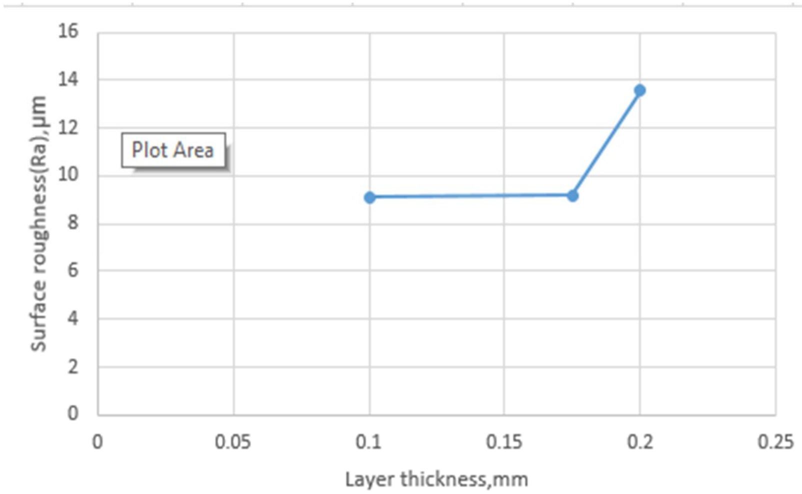

Fig. 2: Surface roughness versus layer thickness

B. Surface roughness of post processed specimens

Surface roughness of specimens polished with emery paper
Figure 3 shows the surface roughness of specimens polished with emery paper of grade 120,150,220 and 320. It is observed that the surface roughness is best for the specimen with lesser layer thickness. This can be attributed to the good surface finish already achieved as discussed in section 3.1.

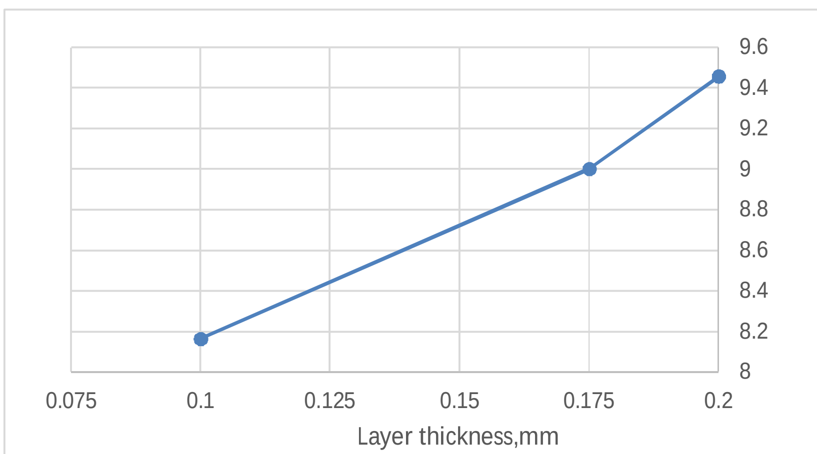

Fig. 3: Emery paper VS surface finish with 0.1 mm layer thickness

Surface roughness of specimens after treatment with acetone
Figure 4. shows the surface roughness of the specimens treated with acetone. It is observed that the surface roughness of the specimens is increasing with increase in layer thickness. This can be attributed to the good surface finish already achieved as discussed in section 3.1.

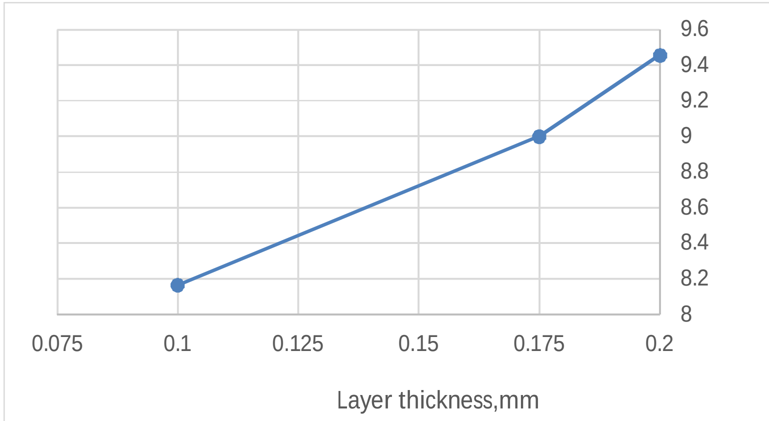

Fig. 4: Surface roughness versus layer thickness

IV. Conclusion

As the layer thickness increases the surface roughness of the specimens produced by the fused deposition modelling parts increases. Polishing with emery paper with 120 grade yields a surface finish of Ra 0.6477 µm whereas specimens treated with acetone had yielded a surface finich of 8.1650 µm.

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