Mechanical Properties of Vapour Polished 3D Printed Abs, Abs Carbon Fiber By Development of Automated 3D Print Polisher

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Abstract- *The 3D prototyping methodology is the cutting edge manufacturing technology in the world of fabrication at present. Thermoplastics used in this process produces prototypes building layer by layer on top of each other, where getting a fine and smooth printed part is nearly impossible. Hence there is a huge demand for the post processing of the 3D printed parts that drew the idea of this project. There are methods for the post processing or finishing of the 3D printed prototype but they are abstract and empirical. Under such circumstances, development of a simple and economical post processing unit could be initiated for the enrichment of the 3D printed parts. The niche of this project will be to design and develop a table top vapor smoothening system for ABS 3D printed parts for real time applications like prosthetics and orthotics. The 3D printed part will be incorporated through few steps of processing in order to achieve a smoother finished 3D printed part. In this project shows the methodology of development of automated 3D Print Polisher for the application of Acetone and Tetrahydrofuran vapors as post-processing method on 3D printed topography, which enables the surface roughness to be reduced significantly, besides it gives impact on the tensile strength and the percentage of porosity. This process is much easier and economical.*

Keywords- Tetrahydrofuran, Timers, Vapor smoothening

I. INTRODUCTION

Additive manufacturing (AM), also known as three-dimensional (3D) printing is capable of forming complex 3D parts via layer-by-layer deposition of material that fuses to form a cohesive bond. The ability of 3D printing to produce parts at low tooling costs, with reduced lead times and flexibility in the design process, serves as its advantage over traditional manufacturing processes. Unfortunately, material extrusion parts often have a poor surface finish, with large layers and visible stair-stepping.

In this project, an automated 3D Print Polisher has been developed to apply Acetone vapors and Tetrahydrofuran vapors on the surface of Acrylonitrile Butadiene Styrene (ABS) and ABS Carbon Fiber prints, there by giving them a smooth, polished appearance. The effect of this treatment on the strength of parts has been studied by using tensile test. The changes in the profile and geometrical dimensions of the sample has been measured using surface profilometry test.

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II. EXPERIMENTAL METHOD

The objective of this project is to design and develop a table top system for vapor smoothening of 3D printed Acrylonitrile Butadiene Styrene (ABS) parts. The primary focus will be on the development of an indigenous system using acetone as a key reagent for the process. The 3D printed ABS parts will be instigated into the system for smoothening of its surface and is envisioned for its usage at home.

III. CHEMICAL USED

TETRAHYDROFURAN: Tetrahydrofuran is a general purpose, highly volatile organic solvent. It is a colorless, water-miscible, mobile liquid. In the various synthesis processes it is used as starting material as it has good solubility. THF can be recovered easily, without decomposition, from off-gas streams and contaminated solvents, making it suitable for closed-loop processes designed to avoid pollution.

IV. AUTOMATED ULTRASONIC POLISHER FABRICATION

Components used for fabrication

(1) Cool Mist Humidifier
(1) Solvent-Proof 12V Pump Assembly
(1) Diaphragm motor
(1) RTV Silicone Glue
(1) 12V Digital Timer Delay Relay Module
(1) 17 Cup Clear Air-Tight Polypropylene Tupperware Bin with Flip Lid
(1) 18.5-Cup Clear Air-Tight Polypropylene Tupperware Bin
(1) 1.2-Cup Clear Air-Tight Polypropylene Round Bin
(1) 120VAC to 12VDC Power Adapter (~2 A+)
(1) Computer Case Fan (I used 40mm^2 x 20mm deep)
(4) Adhesive Mounting Strips or a roll of Double Sided Foam Tape
(1) Electronic switch - SPST toggle
(1) Electronic switch - Momentary
(2) Tube Fitting

WORKING OF AUTOMATIC 3D PRINTED COMPONENT POLISHER

Whenever the power is being supplied, the timer unit (as preprogrammed), controls the functioning of the humidifier. The function of the humidifier is to humidify and create mist out of Acetone or THF. Now the timer controls the working of Humidifier and the formed mist is been moved to the box with the 3D printed component with the help of diaphragm motor. The purpose of fan is to fasten the movement of mist.

1. CAD model of the part that to be printed is prepared using any CAD software.
2. CAD file is then converted into STL format by stereo lithography technique.
3. G-code is then generated using appropriate software.
4. This G-code is fed to 3D printer and then part is printed. In this way 3D part is obtained.
5. As this printed part as markings of layer by layer material addition it minimizes aesthetic look of the object hence vapor polishing the best post processing method is performed.
6. Heater placed at the bottom of the system heats acetone to convert into vapor.
7. This vapor polishes 3D printed part by reacting with ABS material
8. Acetone vapor melts the material on the surface of the part such that its roughness gets reduced. It does not reduce total mass or geometrical parameters of the part.

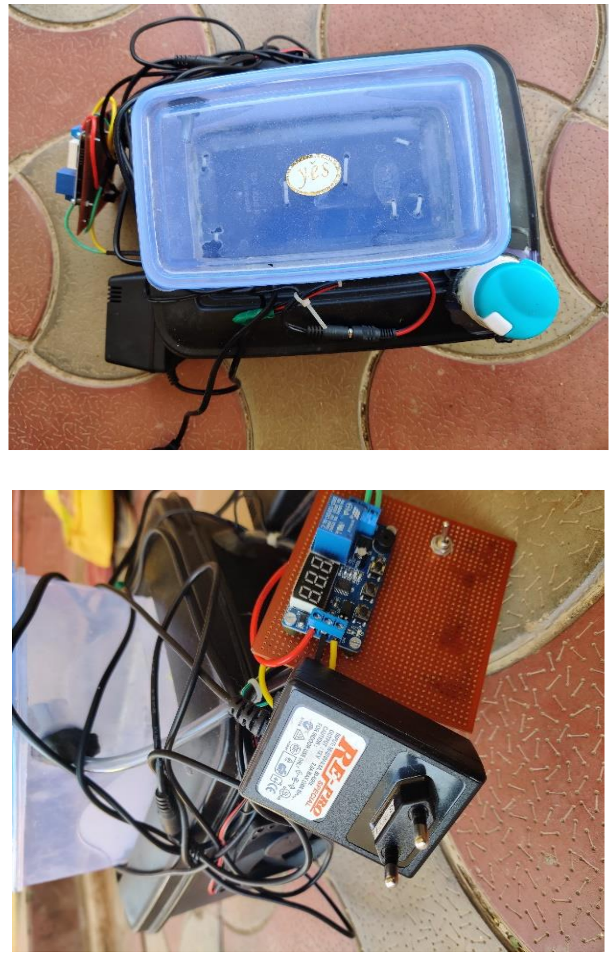

Figure 1: Automated 3D Print polisher

V. RESULTS AND DISCUSSIONS

Many test specimens we printed through 3D printer and then polished by acetone vapor with sophisticated system. By observation we observed dramatic change in the surface roughness of all specimens after polishing compare to that of before polishing. From the available data we plotted graph of the surface roughness showing change in the surface roughness of four same test specimens before and after vapor smoothing for the same interval of time. On the Y axis of the graph values of surface roughness in micrometer are provided while on X axis numbers of specimens are provided.

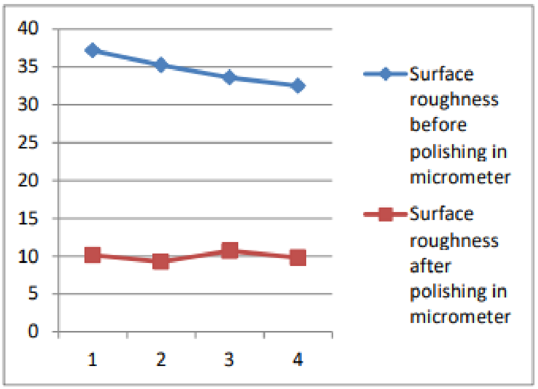

Figure 2. Graph showing change in surface roughness

Also, we can state that surface roughness is inversely proportional to time in case of vapor smoothing. More the time for which part and vapor are in contact less will be the surface roughness value. We polished four same specimens for different time intervals. First specimen kept in chamber for 5 seconds, second, third and fourth for 10, 15, 20 seconds respectively. Then we observed that we get better surface finish if it is kept in contact with acetone vapor for more time.

VI. CONCLUSION

Vapor smoothening of the 3D printed ABS part using a table top system incorporating acetone as a medium was carried out successfully to an extent. This method of post processing of the ABS 3D printed part for smoothening its surface was iterated on visual inspection on time constraints which was an abstract method turned out to be worthy enough. This method was one of the fastest and less costly approaches of smoothening of the 3D printed part made from ABS thermoplastics. Proper care was taken during the process in order to avoid the accidental melting of the 3D printed part. By the end, we can indicate that this sort of process might be included in domestic or small business manufacturing cells, increasing the flexibility, productivity and quality of parts. This might push industry strategy to change in a short term future and migrate from a centre manufacturing to a distributed manufacturing system. Although this process concept is shown to work, there are still further studies to be done in order to better understand the impact of different smoothing techniques and their control parameter on object properties.

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