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A REVIEW ON SELECTIVE DEPOSITION LAMINATION 3D PRINTING TECHNIQUE

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Abstract- The market for Additive manufacturing is constantly rising in everything from the automotive industry to ceramics. However the major part is still in more traditional areas like prototyping using plastics. While 3D printing do bring benefits such as being quicker and less wasteful than traditional manufacturing, also creating it easier to produce on demand. The problem is that the majority of print material used is still plastic, which is one of the most harmful materials for the environment. This became apparent for us as well; question is why there aren't more sustainable materials for 3D printing. This has led us to study a method to print with waste paper. Generally the market of materials is growing and there are other alternative materials you can choose from for your prints. As the amount of paper waste per person is at around 80 kg yearly, it is necessary to study wasteful and hugely used material.

Keywords: *Layer, Rapid prototyping, SDL, SLS, STL*

I INTRODUCTION

The processes involved can be characterized as additive manufacturing methods. To have better understanding, one can compare 3DP to milling, which is a subtractive manufacturing method. Rather than take away from a model, a 3DP adds mass to form a model. Utilizing cutting-edge technology, a 3DP has the ability to create a model using many types of materials, such as plastic, polymer, metal, and composite materials. 3DP is currently being used in many professional career fields, especially those associated with engineering and biology. 3DP is changing our life, allowing many types of products to be designed faster and easier, right where they need to be. The beginning of 3DP can be linked to the studies of photography, sculpting, and landscape design, taken place in India over a century ago.

II LITERATURE REVIEW

[1]Direct Tool Production (DTP) by Laminated Manufacturing techniques such as Selective deposition lamination (SDL) & laminated object manufacturing is widely studied to replace conventional tool production techniques. The advantages we get from such techniques are decrease in both production time & cost for production. The major problem in this technique is "Staircase" effect occurs due to distinct height of laminated sheets. Their work shows experimental study to reduce "staircase" effect by use of slant cutting & laser cutting. **[2]**Laminated Manufacturing technique is a rapid prototyping process which built part sequentially from layers of paper. Their work shows the precision and accuracy of the Laminated Manufacturing techniques & the dimensional stability of their parts. The dimensional error was the largest normal to the plane of the paper, exacerbated by the moisture absorption and subsequent swelling. The key process parameters were identified and optimized for sufficient bonding and cutting accuracy. **[3]**Their work shows an analysis of warping occurs in the Laminated Manufacturing technique. Based on their study of thermal-mechanical behavior of the adhesive and its effect on the laminated materials, the cause of warping, the relationship between temperature and adhesive viscosity, and the adhesive connecting intensity is investigated. An optimal combination of the processing parameters may remove the undesired warping effect. **[4]**Generally manufacturing processes where tool has to move along prescribed path to perform machining operation has an excellent application of for this problem found in layered Manufacturing technique where the laser traces the profile of a layer by moving along the path while the laser turns on. The path is typically followed by a sequence of curves. For typical paths, more time may be wasted in the advancement of tool in between the end point of one curve to the start point of the next curve along which the laser is turned off. Generally, this non cutting motion generates straight line to minimize the distance. A maximum linear intersection (MLI) algorithm is introduced to solve this problem. **[5]**In their work the principle of sheet metal Laminated Manufacturing techniques is described as well

as the process chain of Laminated Object Manufacturing of metal foil. For each sub-process of metal foil Laminated Manufacturing techniques the results of the experimental work for qualifying and optimizing the sub-process are shown. Finally some examples of possible applications especially in the field of Rapid Tooling in Rapid Manufacturing are discussed. **[6]**A 3D printer is a machine that uses a CAD (Computer Aided Design) model to perform rapid prototyping. While traditional 2D printers use ink to print digital information onto paper in two dimensions (x and y axes), 3D printers have the ability to print in three dimensions. (x, y, and z axis) **[7]** This is a research paper on 3D printing and the various materials used in 3D printing and their properties which become a notable topic in technological aspects. They go into the history of 3D printing and study about the process of 3D printing and what materials used in the manufacture of 3D printed objects and select the best materials among them which are suitable for our 3D printing machine. **[8]**Adaptation of 3-D printing technology in manufacturing of proto-typing is increasing rapidly in customized low volume components. 3-D printing encompasses a wide range of additive manufacturing technologies, each of these builds objects in successive layers that are typically about 0.1 mm thin. The medical application for this technology is a promising and its usefulness with various advantages makes it very close to real time ones. There have many researches carried out in this field but various names have been suggested for near and very similar technologies. In this review an attempt is made to make out clear classification and categorization of the processes among various researches down the history. **[9]**Subtractive manufacturing processes which usually result in up to 80-90% of the material being wasted, there is seldom any wastage of material in 3D printing. The concept of 3D printing has been around for a long time and its technology has evolved over the years. Different 3D printers make use of different kind of technologies, printing methods and also different kinds of materials. This paper gives a general introduction to the concept of 3D printing, the different types of printing technologies with their advantages, limitation and compares each of them to different criteria such as surface finish, dimensional accuracy, material used, post processing requirements etc. **[10]**3D printing, also called additive manufacturing (AM), is gaining huge attention from leading manufacturers of the world due its high potential to revolutionize the world. In this report firstly, the term AM is defined and its significance is discussed. Some historical background of the technology is also highlighted here. Then the process of 3D printing and the materials used in the manufacture of 3D printed objects are stated. Given the attention around additive manufacturing (AM), organizations want to know if their products should be fabricated using AM. Implications for product development and manufacturing business approaches are discussed. Finally, a conclusion is made based on the references studied and future scope of this technology has been highlighted. **[11]**Current Nano patterning techniques used for integrated circuit fabrication typically rely on a combination of deposition, lithography, and etch steps. Due to alignment issues, Nano patterning is becoming very challenging as device dimensions approach sub-5 nm scales. In recent years, area selective atomic layer deposition (ALD) has emerged as an alternative, bottom-up approach to nonmanufacturing. By limiting the deposition to specific areas, area-selective ALD enables self-aligned fabrication and can reduce the number of processing steps during device manufacturing, such as patterning and chemical mechanical polishing. Since ALD operates in a surface-reaction controlled regime with sequential precursor and co-reactant exposures, separated by purge steps, area-selective ALD is also characterized by growth with precise thickness control and high conformity. **[12]**This paper explains and analyses the additive manufacturing process from its varieties, types and usage of different programming tools. Printing process need to be selected mainly based on applications and the materials used for development. The advantages and disadvantages of this technology towards the significant growth of applications were analyzed and presented in this paper. **[13]**The actual 3D printing starts with knowledge and discerning of the user, secondly, he has to think of material for his use of the printed 3D item. There is a restriction and also a vast variation of material available for 3D printing for the selection to match the necessity of user need one has to think and make a judgment to select. This is a paper on study of 3D printing material and review paper on rapid prototyping technology, its different process and material used for production. Rapid prototype, additive manufacturing and other such technology and process all come under the

umbrella of 3D printing. The power of 3D printing ideation and design of new product across all industries is really where the revolution is captivating place and will continue to thrive.

III GENERAL PRINCIPLE OF 3D PRINTING

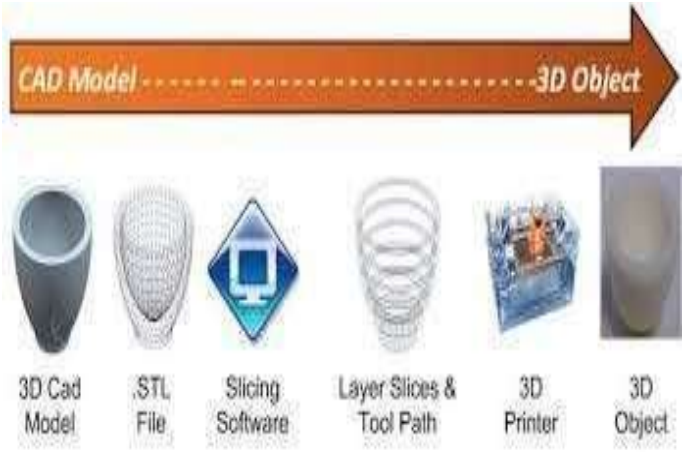

Figure 3.1 3D CAD MODEL

3D CAD model: In this initial step you have to prepare CAD model of your final product. Model is prepared with the help of different CAD software's or through 3D scanners. 3D modeling is nothing but process of analysis and collection of information/data related to shape of object.

STL file: These files are generated by CAD programs, as an end product of modeling process. STL file is a geometric overview of model we prepared initially. This format is used conjunction with 3D slicer, so as to communicate with 3D printer hardware.

Slicing: For 3D printing, every STL file has to open through slicer. Slicer is accommodating to convert digital 3D model into printable instructions for your printer. The instructions are in format of G-codes. Slicer cuts STL file into hundred or sometimes thousands of plane horizontal layers, depending upon you choose. It also calculates amount of material required for printing and time required to print.

3D printer: To perform printing operation machine hardware reads path for tool from slicing data in G-code form and built layered structure sequentially one over another.

Finishing: Most of time layer lines are remain in printed parts making finishing step necessary when we requires high surface finish. Support removal is primary stage in finishing. After support removal, sanding process can be done to finish part or remove any obvious blemishes.

3D object: Finally we get object replicable to initial CAD model.

IV SELECTIVE DEPOSITION LAMINATION (SDL)

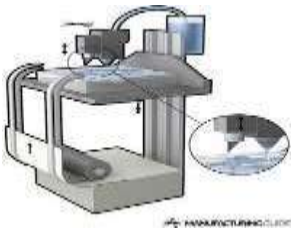

Figure 4.1

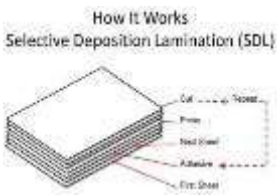

Figure 4.2

The ASTM defines SDL as sheet lamination additive manufacturing process on which sheets of material are bonded to form an object. This is a 3D printing process which uses paper as raw material. It is very similar to laminated object manufacturing process. The process is consisting of adhesive coated papers which are glued successively together with heated roller and cut the shape with cutter layer by layer. From one side roller feeds the paper after completion of each layer to form second one. Material used having very low cost as we can shelf copy papers from any office or store. End product of SDL has wood like appearance thus they can further process using some wood finishing techniques. It differs from LOM in couple regards, mostly in gluing technique. SDL applies glue to part that will form final object, whereas LOM glues entire sheet uniformly. Some of new printers in SDL can produce full color objects by coloring outer edge of the cross section.

V WORKING OF SDL

In the initial stage of process a paper sheet is placed on the platform. In the next step glue is selectively applied to paper, much higher glue for working area & much lower for support area to ensure easy support removal. In the next step new sheet is placed over the previously glued sheet through paper feeding mechanism. Now the built plate is moved up near to heat plate & pressure is applied to have uniform bonding. The build plate then comes to build height, where sharp edge tool cuts one sheet of paper according to design data and forms edge of part. After completion of one sheet, next sheet is deposits until the part is completed.

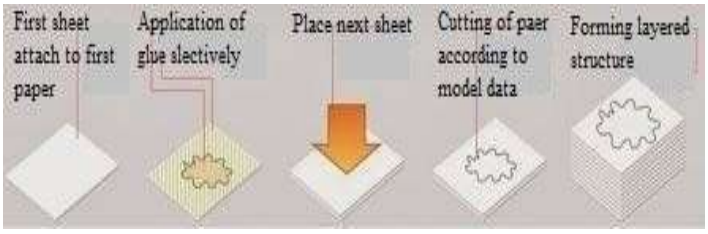

Figure 5.1

To investigate SDL more truthfully a survey is conducted related to stages which justifies name Selective deposition lamination.

1. Selective: The name contains most important word that is selective. It‟s because system offers higher gluing at working area selectively & much lower at support area, which access easy support removal. In other sense LOM process applies glue to whole paper which makes trouble in support removal.
2. Deposition: It is an art of applying glue droplets properly followed by the cutting of paper. This is quite different from LOM process where glue is applied uniformly on full sheet.
3. Lamination: Lamination refers to building layered structure of sheets. The part built are made up of papers & are durable, they don't need to post process to increase strength. Parts made are not brittle in nature, that's why they didn't get break when dropped.

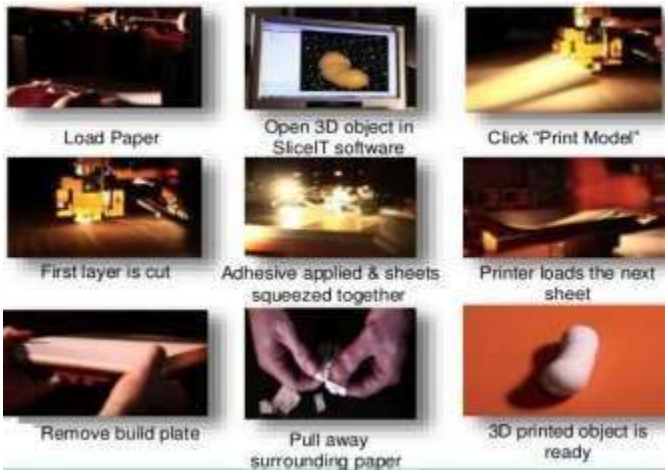

Figure 5.2

VI ADVANTAGES

1. Parts made are ecofriendly in nature.
2. Low running cost.
3. Does not require infiltration of printed parts.
4. No need for additional support.
5. Reliable process.

VII DISADVANTAGES

1. Difficult to fabricate complex thin geometries.
2. Strength part is depends upon adhesive strength of glue.
3. Absorption of water might distort the part.
4. Material trapped in small inner holes is difficult to remove.

VIII APPLICATIONS

3D printing is a new and developing technology, and as with all developing fields the possibilities for improvement and advancement are extremely endless. In recent years, 3D printing has advanced considerably and can now perform vital roles in many applications, with the most significant being manufacturing, medicine, architecture, custom art and design. 3D printing processes are finally catching up to their full potential, and are currently being used in manufacturing and medical industries, which facilitate 3D printing for commercial purposes. There has been a lot of publicity in the last period when discussing to the likelihoods we can achieve by implementing 3D printing as one of the main manufacturing technologies. For a long time, the issue with 3D printing was that it has demanded very large initial costs, which does not allow gainful implementation to mass-manufacturers when compared to standard processes. However, recent market trends spotted have found that this is finally altering. As the market for 3D printing has shown some of the fastest growth within the manufacturing industry in recent years

Figure 8.1

IX FUTURE SCOPE

In future 3D printers would be accessible at a very low cost and can be even used in household applications as it would be reasonable and also very accurate and a multicolor extruder can be used and also the printers would be made movable. In India 3D printing is an exciting and interesting aspect as it is completely new concept.3D printing in rural background is being developing out of India. Most of leading industries are looking forward to have effective printers in their system. Currently 3D printing is at its peak of developing phase. The upcoming years will see a lot of happening in this market that would give a perfect guidance to the organization for the further advancement.

X CONCLUSION

Introduction part is about general overview of 3D printing (3DP). In the next part, we represented general principle of 3D printing step by step. Then we represent basic idea about selective deposition lamination 3DP process. One can conclude that the 3DP technology's importance and social impact increase gradually day by day and affect the human's life, the economy, and modern society. 3DP technology could transform the world. Advances in 3DP technology can considerably change and improve the way we manufacture products and produce goods worldwide. While it may not fill an empty unloved heart, it will provide companies and individuals fast and easy manufacturing in any size or scale limited only by their imagination. 3DP, on the other hand, can enable fast, reliable, and repeatable means of producing tailor-made products which can still be made reasonably due to automation of processes and circulation of manufacturing needs.

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