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A LITERATURE REVIEW ON FABRICATION OF FDM BASED 3D PRINTER

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Abstract: Additive Manufacturing (AM) technologies, especially Fused Deposition Modeling (FDM), have witnessed widespread adoption in various industries due to their flexibility and cost-effectiveness. This abstract presents the design and fabrication process of a customized FDM-based 3D printer tailored for prototyping applications in the field of mechanical engineering. Key components of the printer, such as the extrusion system, are engineered to accommodate a wide range of thermoplastic filaments. A high-precision extruder with variable nozzle sizes facilitates the printing of intricate details. The motion system utilizes precise stepper motors, lead screws, and linear guides to ensure accurate and repeatable layer deposition..

Keywords

3D printing

FDM

Rapid prototyping,

I. Introduction

Rapid prototyping procedures make it possible to produce relatively complicated parts based on computer 3D geometries. Most of the rapid prototyping processes can create parts from a variety of common and special materials. The materials to be selected depend on the type of rapid prototyping technology used. Some technology uses photosensitive resin cured by laser or light from a DLP projector (PolyJet and Stereolitography – SLA). Selective Laser Sintering uses a CO2 laser to sinter or fuse powdered material, mostly plastic. A thin layer of building material is spread across the platform on which a laser traces a twodimensional cross-section of the part, sintering the material together. The platform then descends one layer of thickness and the levelling roller pushes material from the powder cartridge across the building platform, where the next crosssection is sintered to the previous. This continues until the part is completed [1, 3]. (FDM) rapid prototyping systems can fabricate parts in a range of materials including elastomers, ABS (acrylonitrile butadiene styrene), and investment casting wax

2. LITERATURE REVIEW

C. Bohm, [1] When the relationship between education and 3D printing technology was analyzed in terms of subject area, it was determined that there were subject areas shown in the following figure according to the studies specified the in PLA Material. G. Hochleitner, et al, [2] studied the tensile test results indicated that the fracture occurred in the heat-affected zone of the stainless steel base metal. The primary focus of this study liesin the effective application of heat transfer and power electronic applications.

A. Reizabal, B. Tandon, S. Lanceros-M´endez, P.D. Dalton [3] the fluid was modelled using two Bingham constitutive models with different yield stress to represent the printing of wet material onto a semisolid printed layer. The cross-sections of deposited layers, relative first layer deformation, as well as extrusion

J.C. Kade, P.D. Dalton [4] was observed The considerable increase in the amount of martensite is observed when the lower line energy decreases. This outcome indicates that the martensite formed at elevated temperatures had sufficient time to grow.

N.T. Saidy, et al, [5] This is of course attributed to the higher effective viscosity of the first layer when printing wet-on-semisolid. It was also found that the increase in yield stress buildup reduced the deformation in a non-linear manner and that the largest improvement was obtained from the initial increase in yield stress.

M. von Witzleben, et al, [6] Advanced manufacturing technologies should be available to all researchers. Here, we demonstrate the conversion of a commercial FFF 3D printer into a highly capable research tool. The filament mewron provides a tool capable of controlling the flow rates during printing, which opens a new degree of freedom to combine different fiber diameters in a high-resolution scaffold.

M.K. Włodarczyk-Biegun, et al, [7] This also allows for control of the thermal degradation of melted polymers, allowing the expansion of MEW processing to new materials, while introducing MEW and high-resolution structures development to the wider FFF community. The syringe mewron, which keeps the conventional MEW configuration, brings to the MEW community and the eventual new users an accessible and affordable device, easily modifiable, and able to reach high processing temperatures.

O. Bas, et al, [8] Considering all the required components, either commercial or manufactured, for Voron 0.1 conversion into a MEW device, the price stays below 3000 USD, which not only facilitates the acquisition of MEW devices but also provides the platform to explore and integrate new functionalities with less fear of harm, and increases the throughput potential by allowing the possibility of having multiple systems working in parallel. Voron models have similar quality standards and work with the same software, which represents an opportunity to extrapolate the modifications of this work to other Voron printers and achieve new functionality.

T.D. Brown, P.D. Dalton, D.W. Hutmacher [9] Investigation, Funding acquisition, Conceptualization, Project administration, Software, Visualization, Writing – original draft, Writing – review & editing. Henry Jager: ¨ Supervision, Investigation, Resources, Writing – review & editing. Rammile Ettelaie: Investigation, Writing – review & editing. Adele Mohammadi: Software, Writing – review & editing. Peyman Asghartabar Kashi: Software, Writing – review & editing.

I. Liashenko, A. Hrynevich, P.D. Dalton, [10] Multiscale automated image analysis and compositional mapping of the microstructure revealed α-lath size variations as a function of build height and formation of fusion boundaries depleted in V and Fe. The coarsening of the α-laths was accompanied by lower solute partitioning and a lower fraction of the β-phase in the bottom section. At the same time, the refined αmicrostructure towards the top of the build resulted from higher solute partitioning, leading to an increased fraction of β phase. This behaviour is shown to result in a repeated 'saw-tooth' pattern in α lath size and the formation of HAZ bands. H. Xu, et al, [11] Grain boundary α formation and three variant clusters were identified as the two predominant α variant selection mechanisms. The presence of GBα led to the formation of macrozones with strain localisation. The three variant clusters were associated with the autocatalytic nucleation of basketweave α variants. It is concluded that in AM processes with diffusional characteristics, the intervariant boundaries frequently exhibit 60º/[11-20] character, while in processes with shear transformation, the 63.26 º/[− 10 5 5 3] intervariants have the highest population. P.G. Saiz, A. Reizabal, S. Luposchainsky,

J.L. Vilas-Vilela [12] The higher fraction of basketweave microstructure and three variant clustering was shown to provide excellent mechanical strength of the CMT build (i.e., UTS of ~990 MPa) when compared to standards for wrought and cast Ti-6Al-4V. However, the ductility of the build was only 6% due to the limited colony structures in the final product. The breaking up of columnar β grains during CMT also successfully removed the common anisotropy in mechanical properties in other common AM processes. J. Meng, et al [13] CMT is shown to be one of the most promising AM processes that is capable of producing Ti6Al-4V alloy builds with the highest deposition rate ever reported in the literature. The ability to remove the mechanical anisotropy and achieving enhanced properties in Ti-6Al4V alloy makes this process as one of the most suitable AM processes for adaptation in aerospace and other industries.

J.N. Haigh, T.R. Dargaville, P.D. Dalton [14] CMT is shown to be one of the most promising AM processes that is capable of producing Ti-6Al-4V alloy builds with the highest deposition rate ever reported in the literature. The ability to remove the mechanical anisotropy and achieving enhanced properties in Ti-6Al4V alloy makes this process as one of the most suitable AM processes for adaptation in aerospace and other industries.

J.C. Kade, et al [15] 4D printing is still in its infancy phase of research which has developed enormous potential in many areas and produced infinite imagination amongst scientists. In this review, we introduced up-to-date and imperative progress in the application of different types of smart materials in 3D printing in the field of soft robotics, electrochemical energy storage, food science, biomedicine, and bio fabrication. Natural and synthetic biomacromolecules have been widely used to simulate natural circumstances. Concepts motivated by nature allow the progress of engineering biomaterials to attain the natural accomplishment of the fabricated materials. The stimulussensitive components are identified as the cornerstone of the lesson inspired by nature. W.E. King 3rd,

G.L. Bowlin [16] In this work we have presented a combination of SC-DW and ES to fabricate drugeluting PLLA and PLCL BRS for cardiovascular applications. Firstly, 3D-printed stents by SC-DW technique loaded with everolimus were successfully manufactured and characterized, although their drug release rate was found to be too modest, less than 3% of the total loaded drug. Secondly, a customized rotatory ES system was designed and built to effectively coat 3D-printed stents with a membrane of PLCL electrospun fibers, between 800 nm and 1.2 µm in diameter.

R.S. Diaz, E.M. De-Juan-Pardo, P.D. Dalton [17] The versatility of the AM approach used in this study constitutes an encouraging starting point for supplementary features. For instance, the antiproliferative drug release from the electrospun coating, mostly needed in the first weeks after implantation, could be combined with an anti-thrombogenic drug loaded in the stent struts, which would be released in accordance with polymer degradation. Future perspectives include drug characterization in terms of stability and bioactivity prior to cell culture assays with endothelial cells and smooth muscle cells to assess drug effects on cell proliferation. Moreover, together with the preferential alignment of fibers in the longitudinal direction, the electrospun membrane may be functionalized in order to guide endothelial cell migration until complete reendothelialization of the scaffold. M.J. Vernon, J. Lu, B. Padman, C. Lamb [18] This project was conducted to establish the foundation for a surface defect detection system for 3D-printed objects. The project has achieved four main accomplishments. First, a functional prototype of an automated imaging system has been built based on the e 2-stage defect detection system proposed, which can consistently capture clear images from 270 degrees of flexible angles. Nonetheless, perhaps the most significant contribution of this study is the creation of the first pixel. S. Luposchainsky, S. Jorissen [19] The diversity and the size of the dataset's sufficiency were shown by Model-O1's IoU score of 0.8704 against the validation dataset, a result which simultaneously shows SegFormer's optimization and generalization capability. Then, a data augmentation method mixed with synthetic data creation was demonstrated while not overwhelming the training data with randomly cropped 3DP object region, which is often insufficient to infer it to be a 3DP object. The final dataset, Mixed Dataset, amounts to a total of 20,300 real images and synthetically created images. Although only 20,300 training data were created using the hybrid method, there is no real limitation to producing more data.

T. Baroth, S. Loewner, H. Heymann, F. Cholewa, H. Blume, C. Blume [20] As every aspect of research is having limitations, so this 3D printer is having limitation of surface roughness. The prototype manufactured with this 3 D printer is having less surface finish as compared to metallic prototypes. In this research work, the performance of the additive manufacturing unit (3D printer machine) is improved using the dual nozzle head assembly. With this machine, it is possible to develop printing with two colors. The develop machine can provide two difference filament materials within one consistent model. The newly developed machine provides a solution for additive manufacturing of complex geometry products/ customized products required for automotive, aerospace, and robotic applications. Also, the total weight is reduced by 40 % in comparison with existing 3 D printers and the production rate is doubled.

K.F. Eichholz [21] It is generally accepted that 3D printing will be a revolutionary force in manufacturing, whether positive or negative. Despite Concerns over fraud, many companies are already using the technology to repeatedly produce intricate components, for example in automotive and aerospace manufacturing. There will be major challenges for the conventional manufacturing industry to adapt to these changes. The opportunities for technology and engineering are clearly huge, however, and the creative possibilities in product design and printing material formulation are nearly endless. Hence in our project we tried to minimize the machining time while changing various parameters like Layer Height, Nozzle Diameter and Travel Speed along with keeping some parameters at constant such as Filament Diameter, Printing Temperature, Bed Temperature, and Shell Thickness. By varying the variable parameters we came to the conclusion that by increasing the layer height, nozzle diameter and travel speed the machining time will be reduced, similarly by decreasing the value of the same parameters the machining time will be increased. F.M. Wunner, S. Eggert, J. Maartens [22] 3D printing is a promising technology that has numerous applications in various industrial segments. It paved the way to the fabrication of the personalized design products that the customer desires and values highly. There is much evidence in the accelerating growth and diversity of 3D products that a tipping point may be reached well within a decade. It is noteworthy to consider the disruptive effects of 3D printing on the transportation and the supply chains. In fact, 3-D printing could threaten 41% of air cargo, 37% of ocean container, and 25% of trucking freight business. These trends will challenge many port long-term strategic plans and current capital investments to meet US demand management plans.

M. Lanaro [23 The developing world could be a significant beneficiary of AM production but also a loser in manufacturing jobs for export industries. Manufacturing jobs will shift around the world to places where 3D printing technology is involved. The US has high consumption and a good manufacturing economy. In 2017, the total US trade with foreign countries was $5.2 trillion, $2.4 trillion in imported goods. Over 30% of imported good are suitable for manufacture in 3D printed technology, so 3D printing may create more new jobs. Hybrid manufacturing system can integrate AM hubs with existing traditional manufacturing machine shops to decrease investment cost and improve customer services. Thus, locating small distribution hubs near to large cities can save transport costs and provide the swift delivery of products. Moreover, 3D printing would offer numerous opportunities to provide new approaches and solutions to existing transportation issues. When products are fabricated locally using 3D printing near to customers, the freight movement is reduced. Wear and tear of the infrastructure is also reduced. Thus, the maintenance cost of highways and bridges is reduced, and a reduction in vehicle emissions adds more environmental bonuses.
S.S. Crump [24] Currently, cyber security is a big challenge for 3D printing technology: how to keep design files safe? 3D printing will fundamentally change the manufacturing industry. What is the effect of 3D printing technology on traditional manufacturing jobs, and how can those jobs develop to involve a skilled work force? Is it possible to use available local materials to construct appropriate low-cost houses using 3D printing to accommodate displaced persons due to urgent catastrophes such as floods, and earthquakes.
R. Jones [25] The creation of nearly any imaginable geometry can be made tangible using CAD software capable of producing .STL files to be read and fabricated by a 3D printer. Choosing the appropriate printer type, SLA, inkjet, SLS, FDM, or LOM, depends on the design, materials, and purpose of the device. 3D printing has become a useful tool in a number of different fields, and as printer performance, resolution, and available materials have increased, so too have the applications. CMT is shown to be one of the most promising AM processes that is capable of producing Ti-6Al-4V alloy builds with the highest deposition rate ever reported in the literature. The ability to remove the mechanical anisotropy and achieving enhanced properties in Ti6Al4V alloy makes this process as one of the most suitable AM processes for adaptation in aerospace and other industries.
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3. Conclusion
A new composite material with HAP-filled particles in nylon polymer has been successfully developed for direct application in the Fused Deposition Modelling rapid prototyping process. The flexible filaments of the new material have been successfully produced and processed in the existing Inspire D290 machine to produce sample parts. Future work will concentrate on investigating other composite materials, such as copper, iron, or Al_2O_3 in conjunction with PA12, polyethylene, and PLA materials. Also, it is necessary to examine the mechanical and thermal properties of these materials. Fused Deposition Modelling method allows the use of a wide variety of thermoplastic materials with the possibility of combining them with the ceramic or metallic powders. This enables the development of composite materials with improved internal structure, as well as mechanical and thermal properties. This technology can also be used in medical applications such as bone tissue engineering, development of customized prostheses, etc.

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