

A REVIEW ON ADDITIVE MANUFACTURING (AM) MATERIAL - STATISTICS AND COMPARISONS

¹Ch.Manoj, ²K.Hemanth Kumar, ³P.Teja, ⁴M.DileepKumar, ⁵Kona Ram Prasad.

^{1, 2, 3, 4}Students, Department of Mechanical Engineering, N. S. Raju Institute of Technology, Affiliated to JNTUGV, AP, INDIA

⁵Assistant Professor, Department of Mechanical Engineering, N. S. Raju Institute of Technology, Affiliated to JNTUGV, AP, INDIA

Abstract

Fused deposition modeling, also known as FDM, boasts a major edge in the manufacturing industry for its remarkable capacity to craft intricate components sans pricey tooling or manual labor. As is the case with any engineering process, selecting the right process parameters plays a critical role in determining the quality of FDM products. Hence, precise calibration of these parameters is essential to elevate the durability and functionality of printed parts. Our study seeks to explore the influence of five crucial FDM parameters, including layer height and shell thickness, on the tensile strength of build parts, with the ultimate goal of optimizing overall product performance.

Keywords: Fusion Deposition Modeling (FDM), Shell thickness, precise calibration, durability, functionality of printed parts.

1. INTRODUCTION

The advent of 3D printing, also known as additive manufacturing, has truly revolutionized modern manufacturing, design, and prototyping. It has ushered in an era characterized by unprecedented freedom, enabling the creation of intricate geometries and swift iteration of prototypes. As we witness the rapid evolution of 3D printing technologies, it becomes increasingly evident that its applications span across a myriad of industries, including aerospace, medicine, architecture, and consumer goods. Yet, concealed within every triumphant 3D printing venture lies a pivotal decision, one that often wields the power to determine the quality, efficiency, and reliability of the entire process: the selection of the appropriate printing material.

In the world of 3D printing, a material is far from a passive entity; it emerges as a dynamic factor that exerts its influence at every stage of the printing journey, sculpting the properties of the final product. The choice of material extends its reach beyond the mechanical and thermal attributes of the printed object; it imparts a measure of durability, defines aesthetics, and even exerts an influence on environmental sustainability. Therefore, the act of informed material selection emerges as the linchpin in the quest to optimize 3D printing performance and bring forth the desired outcomes.

The pages of this research paper are an invitation to embark on a profound exploration—a journey that seeks to unveil the intricate interplay between material selection and the enhancement of 3D printing performance. At its core, our objective is to furnish you with a comprehensive understanding of the ways in which various materials, each endowed with unique properties and attributes, can be tactically chosen to address the specific challenges and objectives posed by 3D printing. We shall navigate the multidimensional realm of material selection, embracing considerations that span from material compatibility and printability to post-processing requirements and the harmonization of material properties with the intended application.

But we aspire to go beyond theoretical elucidation. This paper aspires to be a practical beacon, illuminating the path for practitioners, engineers, and designers. Within these pages, you will discover not only the theoretical foundations of material selection but also practical guidelines and a systematic framework that will empower you with the knowledge and tools necessary to make judicious decisions when selecting materials for 3D printing. As you leverage this framework, you shall find yourself better equipped to satisfy demanding performance criteria, curtail production costs, and minimize the wastage of materials.

Throughout this expedition, we shall draw upon a synthesis of existing research, imbued with the wisdom of real-world case studies and tangible examples. Together, these elements will bestow upon you a holistic perspective, granting you a profound insight into the profound impact that material selection wields in the domain of 3D printing. Our aspiration is that this paper shall not merely be an academic exercise but a valuable resource—a torch guiding both newcomers and experts in the field. It

is our fervent hope that it shall kindle within you a deeper appreciation for the pivotal role played by material selection in the pursuit of excellence within the realm of 3D printing.

In the pages to come, we shall venture into the multifaceted world of material selection, unraveling critical considerations, revealing methodologies, and illustrating practical applications. Together, these facets shall coalesce to enhance the performance of 3D printing, unveiling new horizons and possibilities.

This introduction serves as our overture—a prelude to the symphony of knowledge and insights that awaits you in the subsequent sections. It seeks to underscore the significance of informed material selection within the context of 3D printing, and it offers a glimpse into the roadmap of what you may expect to unearth as you traverse this paper's intellectual terrain.

2. STATISTICS BASED ON THE MATERIALS

This study examines the impact of five additive manufacturing variables on the creation of parts using fused deposition modeling (FDM / 3D printing). These variables include shell thickness, layer height, infill density, orientation angle, and printing speed. Conducted through a L16 fractional factorial design, experiments were carried out to collect data on load at break (KN) and evaluate its effect on the tensile strength of ASTM 638-10 type I specimens created with FDM. To better understand the non-linear relationship between the control parameters and load response (KN) for tensile strength analysis, the fractional factorial design was transformed into a customized response surface design.

2.1 PLA 3D PRINTING FILAMENT PROPERTIES:

- PLA filament boasts a sturdy composition with a slight vulnerability, making it a popular choice for 3D printing.
- Ideal for creating aesthetically pleasing prints, prototypes, and functional desktop fixtures with minimal stress.
- Considered the top option for novice 3D printers thanks to its user-friendly printing process and reduced warping.

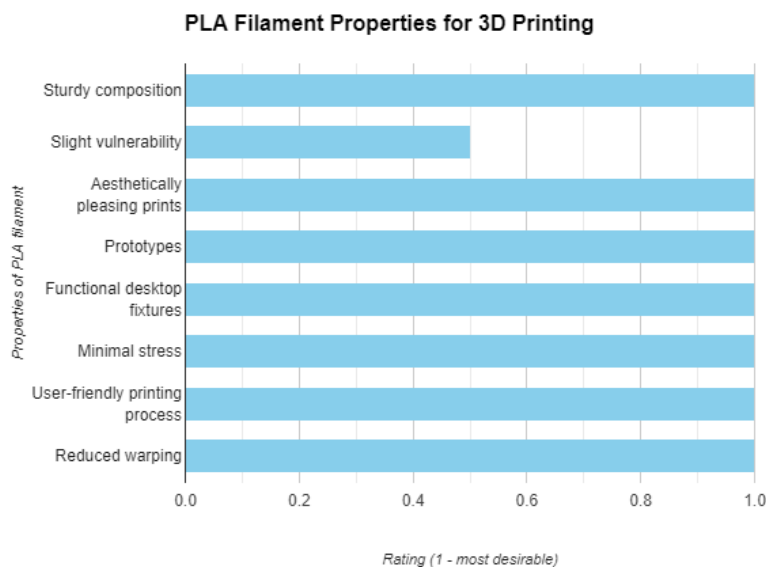


Figure 1: Pla 3d Printing Filament Properties:

2.2 ABS 3D PRINTING FILAMENT PROPERTIES:

Featuring a robust and pliable composition, ABS filament is a durable material that offers superb resistance to wear and heat. Commonly used in 3D printing, ABS is ideal for creating interlocking parts such as gears, as well as for crafting components

that are exposed to UV radiation and high temperatures, like a car cup holder. Moreover, ABS offers a wide range of options for exceptional post-processing techniques.

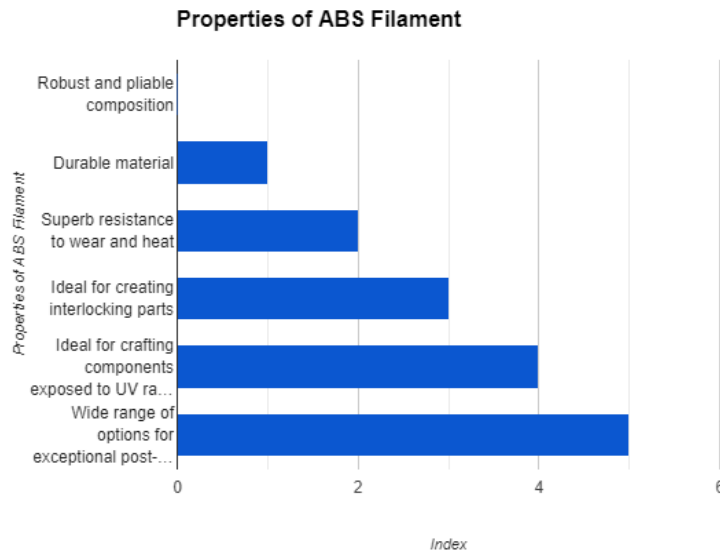


Figure 2: Abs 3d Printing Filament Properties:

2.3 PRO SERIES PLA 3D PRINTING FILAMENT PROPERTIES:

Introducing PRO Series PLA filament - a sturdy yet delicate material available in a vibrant array of hues. Perfect for creating stunning visual prints, crafting prototypes, designing charming desk trinkets, or tackling simpler projects with ease. This is an ideal option for beginners, as it boasts minimal shrinkage and warping

2.4 PRO SERIES ABS 3D PRINTING FILAMENT PROPERTIES:

ABS filament is a fantastic choice for 3D printing due to its sturdy yet fragile composition. It excels in constructing interlocking components, as well as for creating durable parts that can withstand exposure to UV rays and high temperatures, such as a car cup holder. Additionally, it offers a plethora of post-processing options, making it a top-rated option among 3D printer materials.

2.5 TOUGH PLA 3D PRINTING FILAMENT PROPERTIES:

With its impact strength being on par with ABS, this material is highly suitable for real-world use. • Its effortless printability and dependability make it the perfect choice for creating models with significant dimensions.

When used alongside PVA, this material produces impressive 3D prints of intricate curves, intricate details, and challenging overhangs

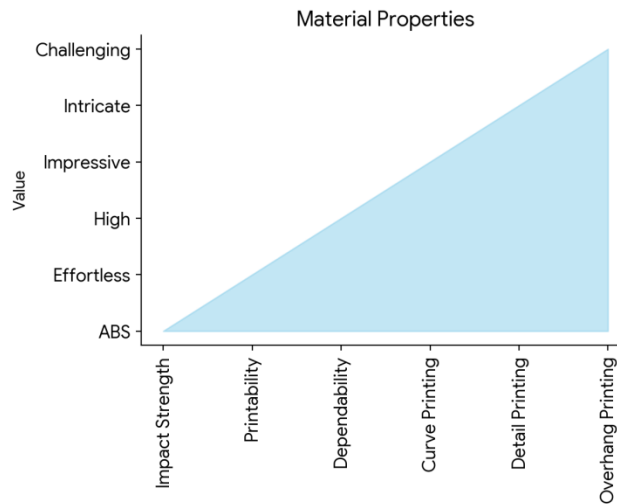


Figure 4: Tough Pla 3d Printing Filament Properties

2.6 NGEN 3D PRINTING FILAMENT PROPERTIES:

Experience the superior quality and versatility of NGen filament, a robust but delicate 3d printing material. Boasting a flawless surface finish, it is perfect for both aesthetic and utilitarian designs. With its user-friendly printing process and minimal adjustment requirements, NGen is ideal for all skill levels. And, unlike other materials, it offers a low-odor experience similar to PLA, while also providing the heat resistance capabilities of ABS.

2.7 GLOW-IN-THE-DARK 3D PRINTING FILAMENT PROPERTIES:

Glow-in-the-dark filament is a remarkable alternative to traditional filament, boasting the same excellent properties but with the added benefit of glowing in the dark due to added pigments. It's a popular choice for a variety of unique creations, such as light switch covers, ceiling stars, and charming novelty decorations. This versatile filament is available in PLA, ABS, and TPU options, making it accessible for various project needs.

2.8 NYLONX 3D PRINTING FILAMENT PROPERTIES:

Nylonx filament boasts the strength of carbon fiber and the durability of nylon, making it an ideal choice for challenging functional parts, wearable's, and high-quality prints. Furthermore, its prints require zero post-processing, making for a hassle-free printing experience

2.9 WOOD PLA 3D PRINTING FILAMENT PROPERTIES:

Experience the lifelike appearance and texture of wood with our revolutionary wood filament, designed to print effortlessly with PLA technology. Perfect for creating intricate wood busts, sculptures, or tikis that would traditionally require expert carving skills. Adjustable extruder temperatures allow for a range of wood tones to be achieved, with hotter temperatures resulting in a richer, darker finish.

2.10 BENDLAY 3D PRINTER FILAMENT PROPERTIES:

Looking to print beautiful, delicate objects with your 3D printer? Look no further than BendLay filament. With its impressive 91% light transmission, this tough and ductile material is perfect for creating ornate cups, containers, and other translucent objects. What's more, its high layer adhesion and food-safe properties make it a top choice for printing functional cups and containers as well. Don't settle for anything less than the best – choose BendLay filament for your next 3D printing project.

3. COMPARITION (CHART)

The main point of the data is to show the characteristics of factors such as materials, variable costs, machine capacity and so on.

Here in Fig.3 is material comparison between PC,TPU, NYLON, PET,ABS,PLA where each of them represents their actual color,and LAYER ADHESION, HEAT RESISTANCE, IMPACT RESISTANCE, VISUAL QUALITY, MAX STRESS and other factors as they display 0- Tension, easily print in 5 scale.

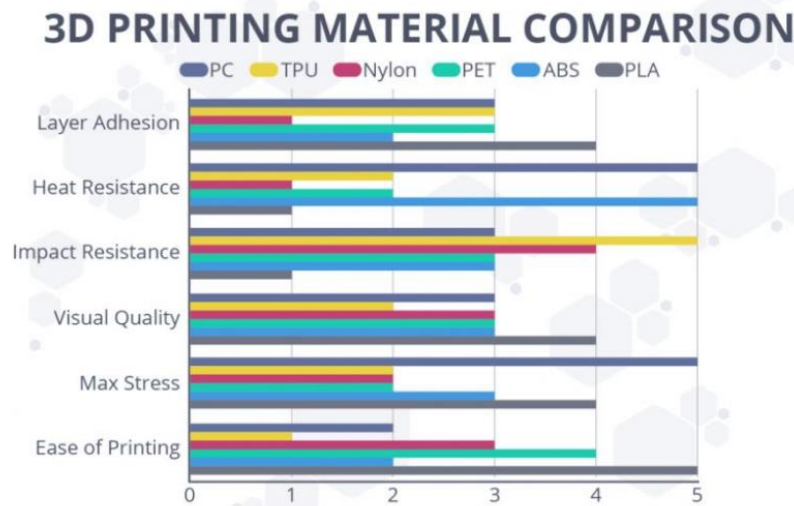


Figure 5: Material Comparison [Bar graph (3)]

4. QUALITY OF MATERIALS

Here the discussion is about the quality of the material on its individually and comparing them with the abilities like ease of printing, visual quality, max stress, elongation break, impact resistance, layer adhesion, heat resistance.

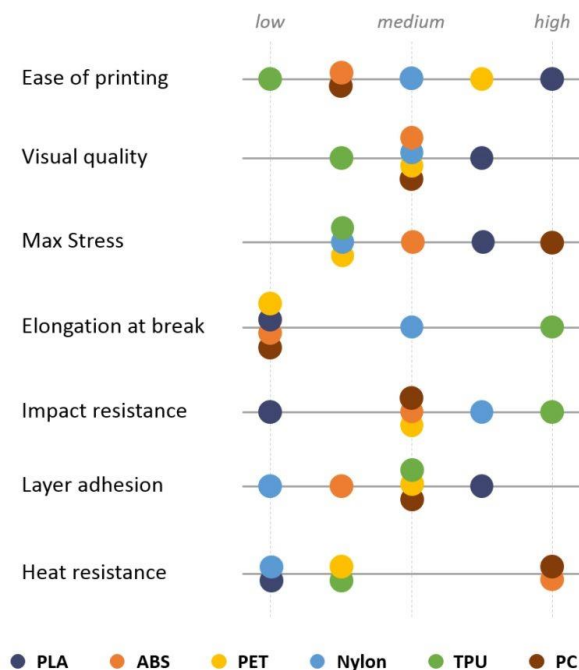


Figure 6: Quality of materials [4]

5.THERMOSETTING FOR MATERIALS. (WITH TEMP. RANGE)

MATERIAL TYPE	PRINTING TEMPERATURE ($^{\circ}\text{C}$)	DENSITY OF FILAMENT (g/cm^3)
ABS	230	1.0311
HIPS	230	1.0280
POLYCARBONATE	250	1.1950
T-GLASE	230	1.2767
NYLON	235	1.1277
SEMIFLEX	230	1.2216
NINJAFLEX	230	1.1869

There a variety of factors including the following densities and types and associated temperatures.

6. MULTI-MATERIALS

Advancements in 3D printing have allowed for the creation of multi-material and composite systems, resulting in enhanced performance at specific user-defined locations. By drawing inspiration from natural structures, this innovative approach allows for the optimization of desirable properties such as hardness, corrosion resistance, and adaptability to different environments in a single component. These cutting-edge technologies have opened the door to exciting possibilities for creating multifunctional components, previously not achievable through traditional single-material 3D printing methods.

7. CONCLUSION

The ten materials used in FDM possess a variety of qualities that make them ideal for both in-office modeling and low-volume manufacturing. Each material has its own distinct characteristics, such as transparency, biocompatibility, FST certification, chemical resistance, thermal resistance, and strength, which set them apart from one another. This makes selecting the right material for the job a straightforward task. In the manufacturing world, materials play a defining role in the production process. With FDM technology, the range of thermoplastic materials offered allows for functional use and has established it as a top choice for additive manufacturing.

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