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A SYSTEMATIC ANALYSIS OF THE MULTI-MATERIAL FFF 3D PRINTING PROCESS FOR BIODEGRADABLE POLYMERS

BY

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Abstract. Multi-material additive manufacturing is an interesting approach for obtaining complex parts with a variety of qualities and functions. Fused Filament Fabrication (FFF) is one of the most widely used methods for 3D printing with polymers. In multi-material FFF, materials with different properties can be combined; however, good adhesion depends on how the materials interact with each other. Therefore, it is preferable to choose chemically compatible materials with similar properties for reliable printing. Creating functional parts with improved properties requires an understanding of all the factors involved in the multi-material 3D printing process. Performing a systematic analysis and creating an Ishikawa diagram is useful because these tools can optimize the production process. The quality of multi-material parts depends on carefully selecting printing parameters, ensuring material compatibility, choosing an appropriate interface geometry, and controlling the thermal process.

Keywords: multi-material FFF 3D printing, biodegradable polymers, systematic analysis, printing parameters, Ishikawa diagram.

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1. Introduction

In recent years, researchers worldwide have focused on conducting studies on biodegradable polymers derived from renewable sources. These concerns have grown steadily and rapidly, directly influenced by the worrying global situation regarding environmental issues and the depletion of oil resources. This has led to the proposal of sustainable recycling and modernization solutions through strict regulations on conventional plastics and increasingly advanced technological innovations (García-Campo *et al.*, 2018).

The use of biodegradable polymers and biopolymers can help solve this problem by reducing the total amount of conventional petroleum-based plastics that remain in landfills. Biopolymers are produced from renewable raw materials (starch, sugar, cellulose, vegetable oils) and emit fewer greenhouse gases compared to petroleum-based plastics. Their impact on the environment is positive due to their natural decomposition process throughout their life cycle. They can be a promising alternative to traditional plastics and are highly useful in the food industry (packaging), automotive industry (interior panels, dashboards), medicine (bioengineering-implantable devices, prostheses), pharmaceuticals, agriculture, and textiles (seat fabrics). A major environmental benefit is that they degrade more quickly in natural environments (soil, water, compost) compared to conventional plastics, which persist for hundreds of years. They can also be easily reintegrated into the circular economy through various strategies aimed at minimizing waste, optimizing resource use, and closing the product life cycle (García-Campo *et al.*, 2018; The Environmental Benefits of Biopolymers, n.d.; Raje, 2025).

Poly(lactic acid) (PLA) and poly(hydroxyalkanoates) (PHA) are polymers obtained from renewable raw materials and represent a scalable and environmentally friendly alternative to traditional manufacturing (Raje, 2025). Poly(lactic acid) is obtained from corn starch, sugar cane, or cellulose and is considered biodegradable because it is derived mainly from biomass. It is one of the most widely used polymers for Fused Deposition Modeling/Fused Filament Fabrication (FDM/FFF) Additive Manufacturing (Mondragón-Herrera *et al.*, 2024). The main advantages of using this material in 3D printing are related to its biodegradability, low cost, ease of printing on a wide range of equipment, good compatibility with other materials (e.g., poly(hydroxyalkanoates)-PHA), high tensile strength, etc. (Stella, 2025; Brancewicz-Steinmetz *et al.*, 2022).

In conclusion, although PLA is easy to process and inexpensive, it has several limitations, such as brittleness, poor impact strength, low thermal resistance, and low elongation at break. All of these make pure PLA unsuitable for demanding FDM applications that require high mechanical performance (Brancewicz-Steinmetz *et al.*, 2022; Korkut *et al.*, 2023; Musa *et al.*, 2022). To improve the strength and mechanical properties of the material, poly(lactic acid) can be combined with poly(hydroxyalkanoates) (PHA) for example.

Polylactic acid (PLA) is the largest biodegradable polymer produced in the world, and its use is widespread in many areas due to its ability to be crystallized, copolymerized, and modified by thermal impact and stress. The fields in which PLA has recently been used include the food industry (packaging, disposable products), medicine (biomedical applications such as tissue engineering, drug delivery, implantology), and pharmaceuticals (hygiene products), (Naser *et al.*, 2021).

Polyhydroxyalkanoates (PHA) are produced by microorganisms through bacterial fermentation of lipids and sugars (Mondragón-Herrera *et al.*, 2024). These microorganisms are cultivated in special fermentation media containing sources of carbon, nitrogen, phosphorus, and minerals (Kovalcik, 2021). Due to their remarkable properties, polyhydroxyalkanoates can be a suitable choice in the production of biodegradable packaging, disposable items, automotive components, bio-implants, cardiovascular stents, biosensors, prostheses, drug delivery and transport systems, surgical clothing, cosmetics, fine chemicals, etc. (Naser *et al.*, 2021).

Fused Filament Fabrication (FFF) is one of the most widely used methods of 3D printing polymers. The method facilitates the production of complex geometries using a wide range of materials, which have applications in various basic fields such as: automotive, electronics, medicine, food, agriculture, etc. (Brancewicz-Steinmetz *et al.*, 2022). One promising method is multi-material additive manufacturing (MMAM), as it allows the creation of parts with complex geometries and high functionality that meet current demand (Mustafa and Kwok, 2022).

Multimaterial FFF (Fused Filament Fabrication) 3D printing involves the simultaneous or sequential use of two or more filaments to produce a composite part. This can be achieved by using a single extruder with automatic switching, which is equipped with a single hot end, with the material change being performed directly by the 3D printer. To clean the nozzle between material changes, the use of a purge tower is recommended, as it removes residual material, stabilizes the material flow, and prevents possible contamination. This type of printing, which uses a standard printer, is considered more difficult because it requires more time and effort (Prior, 2024). An alternative approach for multi-material printing involves using a dual extruder equipped with two separate nozzles, each of which is fed independently. The approach is considered more suitable because it offers better results, but precise calibration of the offset between the nozzles is required for quality printing (Prior, 2024).

In multi-material FFF printing, various materials with different properties can be combined to produce functionally improved parts that meet increasingly complex requirements. However, there are certain technical challenges that researchers in the field are seeking to resolve. The primary issue is poor bonding between filaments and its neighboring extruded layers of two or

more polymers, which leads to voids and lower mechanical performance of the 3D-printed parts (Lin *et al.*, 2018; Rafiee *et al.*, 2020). These problems can be caused by several factors such as chemical compatibility between materials, melting temperatures, different thermal expansion coefficients, total contact surface area (Frascio *et al.*, 2024). To achieve solid mechanical adhesion and reduce the risk of delamination or cracking, the geometry of the interface between materials plays a crucial role. It has been shown that geometries with mechanical interlocking (the best known being T-shaped, dovetail-shaped, and U-shaped) can increase adhesion between materials compared to simple flat interfaces (Frascio *et al.*, 2024; Mustafa and Kwok, 2022). Ribeiro *et al.* (2019) concluded that the strength of the interface joint depends much more on the macroscopic structure of the interface (mechanical interlocking) than on material compatibility and that the T-shape offers the best performance, (Mustafa and Kwok, 2022).

This paper reviews important aspects of the multi-material FFF 3D printing process with biodegradable polymers. Performing a systematic analysis and an Ishikawa diagram provides a solid scientific basis for the complex process factors. With the help of these tools, potential causes of multi-material 3D printing problems can be more easily visualized so that many of them can be avoided. Also, by going through this work, the objective is to identify the most common challenges (compatibility between materials, process parameters, technological limitations), current trends, and possible future research directions in multi-material additive manufacturing (MMAM).

2. Factors involved in the FFF production process

When 3D printing multiple materials, it is crucial to carry out a detailed analysis beforehand to provide as much information as possible about the factors involved in the process in order to obtain a coherent, well-fused part with homogeneous physical properties. Systematic analysis of the process of multimaterial 3D printing of biodegradable polymers can provide deeper insights into the key elements, from material selection and 3D printer configuration to process parameters and results (mechanical properties, defects, variations). Fig. 1 shows the systematic analysis of the multimaterial 3D printing process, which is structured into four major categories: input factors, process, high- risk factors (those variables that are difficult to manage or stabilize consistently), and output factors.

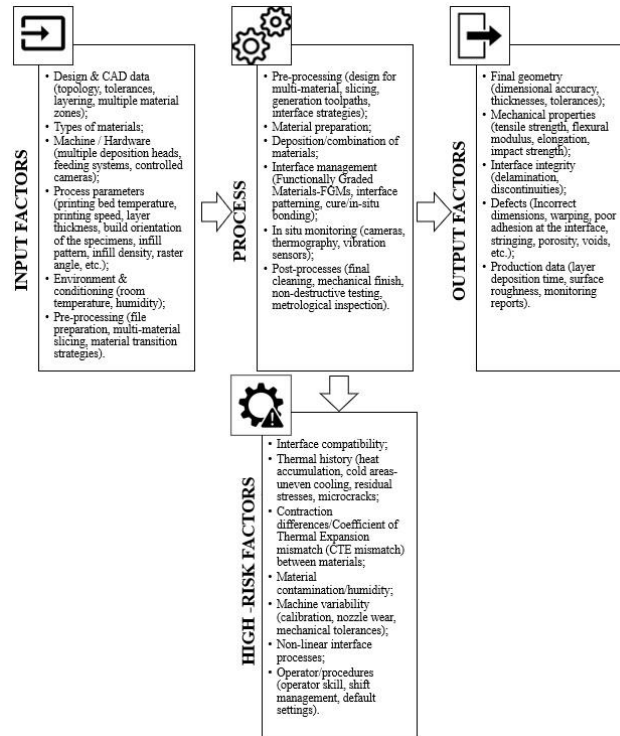


Fig. 1 – Systematic analysis of multi-material 3D printing process (adapted from Ben Said *et al.*, 2025; Fakhr Ghasemi and Pinto Duarte, 2025; Kwon and Hwang, 2025; Nazir *et al.*, 2023; Singh, 2025; Slătineanu *et al.*, 2018).

The following section presents a review of relevant input factors (materials, 3D printer settings, and required printing conditions) that have a major influence on the quality and mechanical properties of the final part.

2.1. Materials used

The combination of polylactic acid (PLA) with polyhydroxyalkanoate (PHA) offers both environmental and functional advantages, but it also presents several technical challenges:

– *improved flexibility*: while polylactic acid is relatively brittle due to its low hardness, blending it with polyhydroxyalkanoate enhances the flexibility of the final material. The proportions of the two materials can be adjusted based on the intended use of the printed product (Mondragón-Herrera *et al.*, 2024);

– *higher temperature resistance*: PHA contributes to better resistance against elevated temperatures, thereby broadening the range of potential applications (Frone *et al.*, 2020);

– *improved biodegradability*: although both materials are biodegradable, their combination can result in a more uniform and rapid degradation process, particularly in varying environmental conditions (Park *et al.*, 2025);

– *balanced mechanical properties*: the blend of these two polymers can enhance tensile strength and durability without sacrificing their biodegradability (Mondragón-Herrera *et al.*, 2024).

The use of biodegradable polymers such as UltraFuse PLA and PLA/PHA can offer interesting and sustainable solutions in the manufacture of multi-material parts, with improved mechanical properties and superior biodegradability, but it also involves overcoming issues related to chemical compatibility, processability (different melting temperatures), production costs (PHA is more expensive than PLA), (Chouhan and Tiwari, 2025). For UltraFuse PLA and PLA/PHA filaments, ColorFabb recommends the processing parameters shown in the table below (Table 1). PLA is biodegradable under industrial conditions, but degrades very slowly in natural environments. PLA/PHA has a higher biodegradation rate than PLA, even under natural conditions such as home composting (Liu Y. *et al.*, 2019).

Table 1

Recommended values for 3D printing processing parameters with UltraFuse PLA and PLA/PHA filaments, (BASF 3D Printing Solutions BV, 2020; colorFabb, 2023)

Recommended settings	UltraFuse PLA	PLA/PHA
Filament Diameter	1.75mm / 2.85mm	1.75mm / 2.85mm
Nozzle Diameter	≥ 0.4 mm	≥ 0.4 mm
Nozzle Temperature	210-230°C	195-220°C
Bed Temperature	50-70°C	50-60°C
Print Speed	40 - 80 mm/s	40 - 100 mm/s
Glass Transition Temperature	≈61 °C	N/A*
Drying	60 °C in a hot air dryer or vacuum oven for 4 to 16 hours	4 hours at 55°C

Note: *N/A= Not Available / not specified by the manufacturer.

The factors influencing the low quality of parts produced by multi-material FFF can be diverse, therefore an Ishikawa diagram has been made in Fig. 2 which gives a clear vision of the six "M" categories (Material, Machine, Measurements, Method, Workmanship and Environment) and aims to identify the root causes and effects so that the multi-material 3D printing process can be optimized. In the *Material* category, from the point of view of 3D printing, compatibility and adhesion between materials are the most important factors, followed by the study of internal stresses. Knowledge of each material's contraction coefficient must be studied before printing.

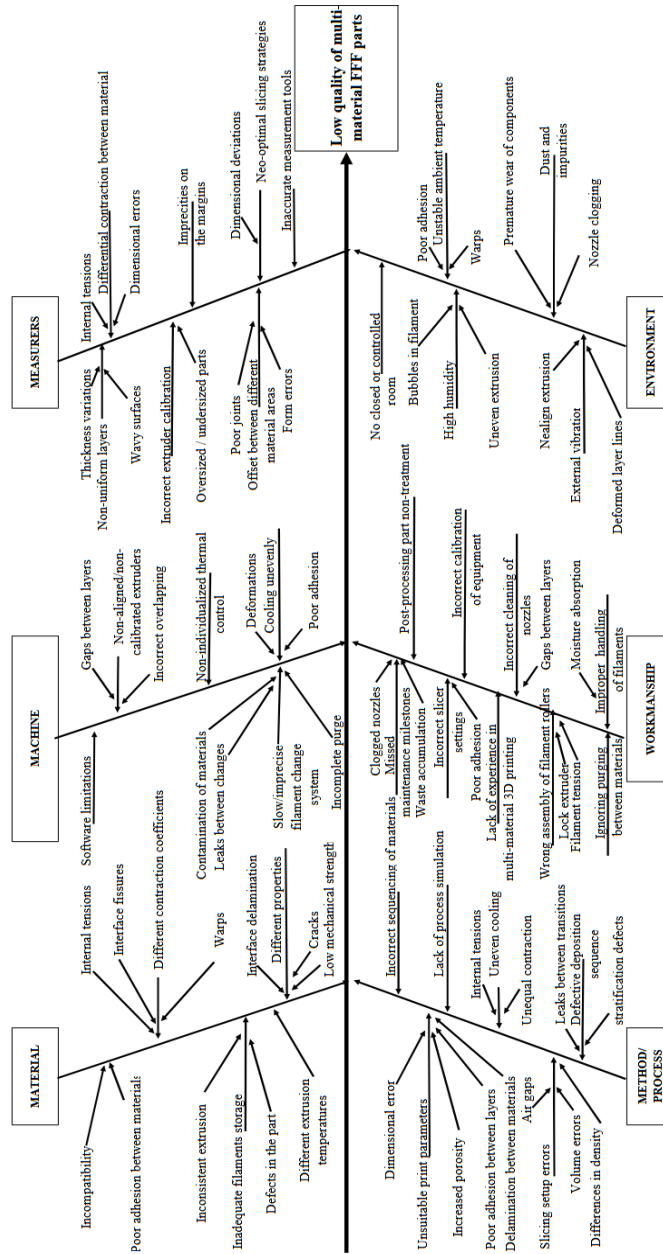


Fig. 2 – Ishikawa diagram of factors influencing the poor quality of multi-material FFF 3D printed parts, (adapted from Delia *et al.*, 2024).

In the next category (*Machine*), extruder calibration plays an important role in obtaining parts of the appropriate quality, a factor that is also found in the *Measures* category because it is clear that this factor directly influences the precision of the parts obtained. In the *Methods/Process* category, an attempt was made not to study inappropriate printing parameters that have no influence on the final quality of the parts. The operator (*Workmanship*) must have the necessary experience in multi-material printing, including the adjustment and maintenance of the printing equipment. The optimal printing situation, in the *Environment* category, is with a controlled temperature of the platform on which the parts are placed and in a closed room. Also, the filaments must be dried at a controlled temperature before printing to avoid possible defects due to humidity.

2.2. 3D printer settings

Achieving high accuracy in multi-material 3D printing requires careful calibration of the nozzles. This process involves fine-tuning various settings and parameters. Any discrepancies in calibration can lead to issues during 3D printing, such as misaligned layers, leaks, inconsistent extrusion, poor adhesion between materials, etc. (3DPrinterAddons, n.d.).

Some recommendations for best practices that can ensure successful printing (Wickstrom, 2025; Printing with Multiple Extruders, n.d.):

- Regular maintenance on the nozzle is crucial for preventing contamination between different materials, and establishing a consistent schedule for this maintenance can greatly enhance print quality.
- It is beneficial to reduce print speeds in critical areas or during transitions between materials; this strategy will promote smooth bonding and contribute to a more visually appealing finish.
- Adjusting the distance and speed of withdrawal can effectively address leakage and mixing issues, thereby improving the overall outcome.
- Implementing a purge tower or drip shield, which consists of a thin wall printed around the main model, can be a valuable practice to capture any material drips that occur during filament changes, thus ensuring greater precision in the printing process, etc.

2.3. Required printing conditions

For bi-component 3D printing of biodegradable materials (UltraFuse PLA-PLA/PHA) using FFF technology, it is necessary to correctly adjust the printing parameters to achieve the desired result. The main adjustable parameters that directly influence the mechanical performance, dimensional accuracy and final part appearance are illustrated in Fig. 3.

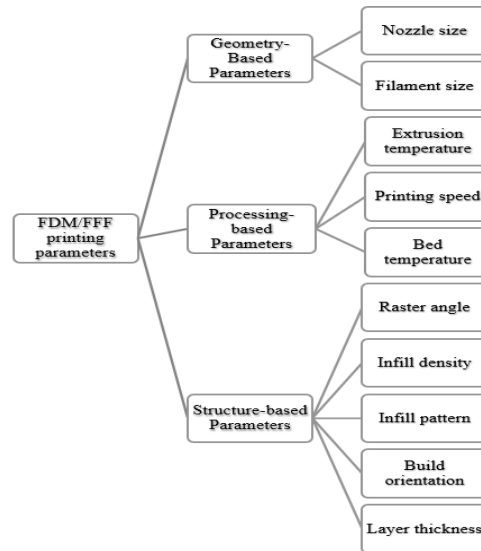


Fig. 3 – Classification of main FFF printing parameters (Sani *et al.*, 2024).

– The printing speed is measured in millimeters per second (mm/s) and is defined as the speed at which the print head (nozzle) moves as it extrudes the molten material to build up each layer of the object. Choosing low print speeds can improve interlayer adhesion and surface quality, but prolong the process time. Higher printing speeds may decrease the manufacturing time of the part but may compromise the quality of the part (dimensional deviations), (Cojocaru *et al.*, 2022). To achieve better strength properties, lower printing speeds are usually used to achieve better adhesion of the deposited layers (Lorkowski *et al.*, 2025).

– The *nozzle temperature* is measured in degrees Celsius (°C) and is the temperature at which the 3D printer's extruder head heats up to melt the thermoplastic filament and extrude it layer by layer during the 3D printing process. This is one of the most important fine-tuning jumps in multi-material FFF printing because the whole process relies on proper melting of the thermoplastic filament. Higher nozzle temperatures reduce the viscosity of the polymer melt and improve the thermal fusion between the layers, thus the mechanical properties are improved, but can cause major defects if excessively high. Also, working at lower temperatures can result in layers peeling off or a brittle part (Cojocaru *et al.*, 2022; Elhatab *et al.*, 2022).

– The *bed temperature* is the temperature at which the 3D printer bed is heated to ensure the initial adhesion of the first layer of the model. It is measured in degrees Celsius (°C) and is a critical parameter for ensuring proper adhesion and minimizing warping. Typically, a well-calibrated bed temperature

can significantly improve print quality and is generally set in the 50-60°C range (Yang, 2025);

– The *raster angle* is expressed in degrees ($^{\circ}$) and is the angle between the filament deposition direction and the X-axis of the build platform. This angle determines the orientation of the lines of material deposited in each layer of the printed part. Typically, the raster angle varies between 0° and 90° , in increments of 15° , thus influencing how the layers overlap and bond to each other (Sani *et al.*, 2024). In FFF 3D printing practice, various raster angle configurations are used (illustrated in Fig. 4) such as: $0^{\circ}/90^{\circ}$ - provides balanced mechanical strength in the XY plane and is typically used for parts requiring structural uniformity; $\pm 45^{\circ}$: lines are deposited alternately at $+45^{\circ}$ and -45° so that a cross pattern is formed. Using this type of configuration can balance the mechanical properties in all directions and improve impact resistance, fatigue (Sani *et al.*, 2024; Qayyum *et al.*, 2022; Bakhtiari *et al.*, 2023). Alternating the angles between layers (e.g. $0^{\circ}/45^{\circ}/90^{\circ}/135^{\circ}$) is an essential approach in multi-material printing as compatibility between materials can sometimes be low. The advantages of alternating raster angles are improved mechanical properties, better adhesion between layers, uniform dispersion of mechanical forces, and a more robust part (Sani *et al.*, 2024; Qayyum *et al.*, 2022).

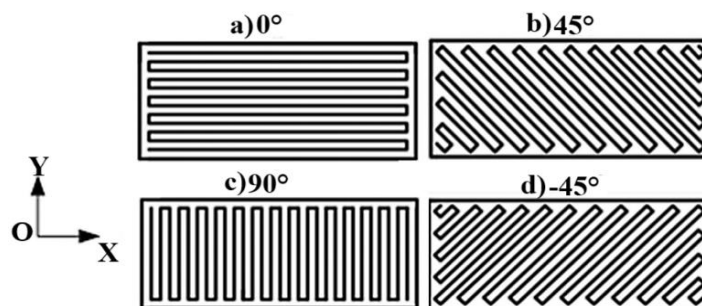


Fig. 4 – Layer deposition with different types of raster angles: a) 0° , b) 45° , c) 90° and d) -45° (Liu *et al.*, 2019).

– The *infill density* is expressed in percent (%) and is the percentage of the volume of the filament filler material to the total volume of the part covered with the filler, where 0% is just the coating and 100% is solid. Usually the outer part of 3D-printed objects is solid and the inner part is filled with different types of fillers (Sani *et al.*, 2024). Impact strength is directly proportional to the degree of infill, so building a part with 100% infill typically yields the maximum impact strength, albeit at a longer printing time (Vălean, 2023). According to a study conducted by Maszybrocka *et al.* (2022) increasing the degree of filling (80% for PLA) resulted in higher compressive strength, whereas a lower degree of filling (10%) decreased the compressive strength.

The mechanical properties were found to be influenced not only by the filling density of the core but also of the outer layers (Chicos *et al.*, 2022).

– The *infill pattern* refers to how the 3D printer distributes the material inside the part (the core), between the outer walls. The choice of infill pattern influences the printing time and speed, material consumption, 3D part weight and mechanical properties. The main filling patterns used in 3D printing are triangular, grid, cubic, honeycomb, concentric, rectilinear, gyroid, tri-hexagon, etc. (Xometry, 2023). Depending on the specific requirements of the part, one of the filling patterns mentioned above can be chosen. For example, when a simple structure that balances strength and efficiency over time is desired, the grid pattern is preferred. The honeycomb pattern offers an excellent strength-to-weight ratio as hexagonal cells can add durability and are generally used when lightweight parts are desired (Raise3D, 2024). More complex patterns (e.g. gyroid and cubic) add structural durability, making them ideal for functional prints (Raise3D, 2024).

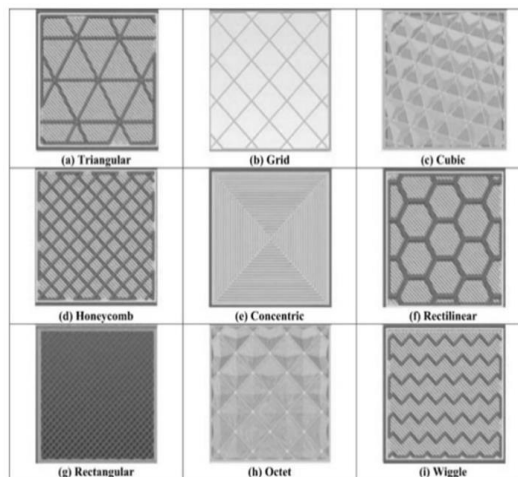


Fig. 5 – Types of filling patterns used for the FDM/FFF process (Patel *et al.*, 2024).

– *Build orientation* refers to the position of the test specimen on the printing platform. This orientation can have a major influence on the final mechanical properties (tensile, bending, compression). The most common specimen orientations are in-plane (on the X-axis), vertical (on the Z-axis) and edge (XZ or YZ). A study by Gonabadi *et al.* (2020) shows that the best mechanical properties (tensile strength of about 55 MPa and a modulus of elasticity of 3.5 GPa) were obtained with the specimen oriented on the edge. This is due to the alignment of the layers with the direction of the applied force, allowing significant plastic deformation. Additionally, the orientation of the specimen in the horizontal (XY) plane gives good mechanical properties but is

slightly inferior to the edge orientation. The poorest mechanical properties were obtained with the vertical orientation (on ZX/ZY) because the force is applied perpendicular to the layers, which favors delamination and brittle behavior (Gonabadi *et al.*, 2020).

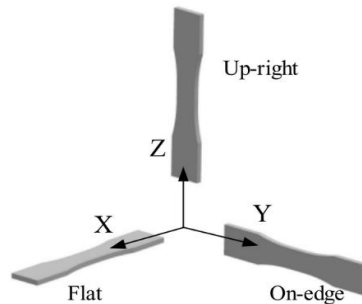


Fig. 6 – Build orientation (Gao *et al.*, 2022).

Giri *et al.* (2021) show that the influence of heat flux on the final tensile strength depends on the orientation of the specimen on the printing table. The results showed that the tensile strength is low when the specimens are printed horizontally and high when the specimens are printed vertically (Cojocaru *et al.*, 2022).

The two studies of researchers Giri *et al.* and Gonabadi *et al.* obtained different results regarding the vertical orientation of the specimen on the printing bed because the thermal printing conditions during the process were different. Giri *et al.* maintained a stable environment that involves a more constant temperature and a controlled cooling. This allowed the previously deposited layers to be maintained at a sufficiently high temperature so that the layers remained hot for a longer time, thus obtaining a better diffusion of the polymer chains and a stronger inter-layer adhesion. Their findings showed that the vertically printed specimens presented a higher strength. In contrast, Gonabadi *et al.* observed that vertical orientation leads to reduced mechanical performance under standard FFF conditions because the layers cooled too quickly limit the inter-diffusion of polymer chains, resulting in weak bonding between layers. In conclusion, vertical orientation of the specimen on the build bed can be an advantage when printing under optimal thermal conditions (controlled heating flux) and can be disadvantageous when thermal conditions are standard.

Infrared thermography (IR), the incorporation of temperature sensors and the use of numerical methods such as finite element analysis can be used to monitor the temperature profile during the FFF printing process (Finite Element Method-FEM), (Vanaei *et al.*, 2021).

– The *number of outer layers* (shells) represents the number of closed paths that are deposited along the edge of the part. In FDM/FFF printing shells are always the first areas that are printed per layer. Thicker outer layers help to avoid infiltration between incompatible or differently shrinking materials. Most shells are printed with a thickness of 2 nozzle diameters (usually this corresponds to 0.8 mm), (Protolabs Network, *n.d.*).

In the work carried out by Vălean, it was observed that with the increase in shells, the mechanical strength of the printed PLA increased considerably. The increase in shells shifts the applied load to the main continuous outer layers. This load distribution reduces weak points inside, uniformizes the stress flow, and significantly improves the mechanical strength (Tensile Strength and Breaking Stress by over 25%) and breaking energy (42.8%) of the printed PLA, (Vălean, 2023).

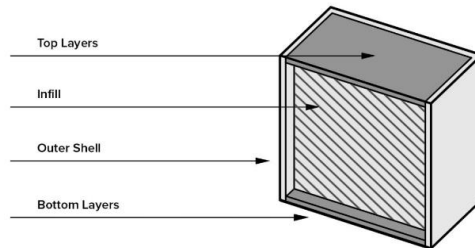


Fig. 7 – Components of the outer layers (Protolabs Network, *n.d.*).

– *Layer thickness* refers to the height of each deposited layer (the top and bottom layers can be set with different thicknesses), which is closely related to the nozzle diameter and raster width. Selecting smaller layer values (thin layers between 0.1 mm and 0.3 mm) can provide better resolution and a smoother part surface, but printing times are longer. Thicker layers are chosen to reduce processing time, but they may have an influence on the mechanical properties (tensile strength, flexural, compressive) and fine details of the parts (Cojocaru *et al.*, 2022). By choosing a layer thickness of 0.2 mm, a good balance between detail and printing speed can be achieved (James, 2024).

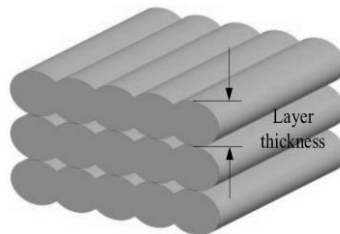


Fig. 8 – Layer thickness (Gao *et al.*, 2022).

3. Conclusions

To improve multi-material part quality and mechanical properties, it is necessary to take into account the interaction between the printing parameters, the materials used, and the part geometry. The choice of compatible materials plays a crucial role in interlayer and inter-material adhesion. Different material properties (e.g., different extrusion temperatures, different shrinkage coefficients, different hygroscopicity and viscosity) may influence the quality and performance of the 3D printed part (structural, aesthetic, or functional defects).

In general, the printing parameters are the same for all materials, i.e., nozzle temperature, printing speed, build plate temperature, raster angle, density and fill pattern, specimen orientation, layer thickness, etc. The critical parameters with a major impact on the mechanical properties are nozzle temperature, build plate temperature, printing speed and specimen orientation on the printing table.

The classification of systematic problems into the 6M categories (material, method/process, machine-tool, workmanship/technician, measurement and environment) provides an overview of the causes and effects that can contribute to the degradation of the final part. With this tool, the main causes as well as effects that may influence the low quality of parts produced by multi-material FFF were identified.

The optimization of the 3D FFF multi-material printing process requires the application of best practices such as:

- choosing compatible materials with similar properties; verification of biodegradable polymers in terms of chemical compatibility (UltraFuse PLA and PLA/PHA filaments have similar compositions, indicating good natural adhesion), extrusion temperatures, cooling and shrinkage behavior (materials with similar thermal coefficients shrink together) and chemical affinity (both UltraFuse PLA and PLA/PHA are based on polylactic acid, and the bonds formed between layers can be quite good);
- selecting suitable print settings as recommended by manufacturers;
- orientation of the specimen in the horizontal plane (XY direction) or on the edge (XZ or YZ) for high adhesion and improved mechanical properties;
- opting for geometries with mechanical interlocking mechanisms (e.g. T-interface or dovetail interface);
- selecting a degree of filling (preferably 100%) and as many shells as possible;
- keeping the filaments in perfect condition by storing them in an appropriate space (moisture in the filaments can lead to air bubbles) and handling them carefully to avoid degradation;
- regular check and calibration of extruders;

- using purge functions (available in RaiseTouch and IdeaMaker software) or purge towers to avoid contamination between filaments;
- controlled and differentiated cooling to achieve good adhesion between layers and avoid cracks at the interface between materials, etc.

Multi-material additive manufacturing can contribute to more complex, high-performance, functionally enhanced parts by carefully choosing the right materials, optimal printing parameters, interface geometry types and cooling for each material.

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ANALIZA SISTEMICĂ A PROCESULUI DE PRINTARE 3D FFF MULTI-MATERIAL A POLIMERILOR BIODEGRADABILI

(Rezumat)

Fabricarea aditivă cu mai multe materiale poate fi o abordare interesantă atunci când se dorește obținerea unei piese complexe, cu o varietate de calități și funcții. Fabricarea cu Filament Fuzibil reprezintă una din cele mai utilizate metode de printare 3D a polimerilor. În FFF multi-material se pot combina materiale cu proprietăți diferite însă obținerea unei bune aderențe depinde de modul în care materialele interacționează între ele. De aceea, este de preferat să se aleagă materiale compatibile chimic, cu proprietăți similare pentru o printare fiabilă. Pentru crearea unor piese funcționale, cu proprietăți îmbunătățite este necesar să se cunoască toți factorii implicați în procesul de printare 3D multi-material. Realizarea unei analize sistemice și a unei diagrame Ishikawa este utilă deoarece cu ajutorul acestor instrumente, procesul de producție poate fi optimizat. Îmbunătățirea calității pieselor multi-material depinde de alegerea cu atenție a parametrilor de printare, compatibilitatea materialelor, geometria de interfață adoptată și controlul termic.