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COMPARATIVE ANALYSIS OF 3D PRINTERS BASED ON FDM AND SLA TECHNOLOGIES

D. MAKSIMENKO, V. KUDRYAKOVA, N. POPOK, S. PORTYANKO
Polotsk State University, Belarus

Introduction. Modeling by the method of fused deposition (FDM) and stereolithography (SLA) are the two most popular 3D printing technologies. Both technologies are adapted and improved, which makes them more accessible, easy to use, and more functional.

The simulation of the application method of layer-by-layer material is the most widely used 3D printing technology at the consumer level. FDM works by extrusion of thermoplastics, such as ABS, PLA, through a heated extruder, material melting and applying plastic layer. These types of 3D printers are well suited for basic models, verification of the concept, as well as for quick and inexpensive prototypes creation.

Stereolithography was the world's first 3D printing technology. Invented in the 1980s, and still remains one of the most popular technologies for professionals. SLA uses a laser for curing a liquid resin into a hardened plastic in the process, called photopolymerization.

3D SLA printers have become extremely popular due to its ability to produce high-precision, isotropic and waterproof prototypes and parts from the most modern materials with excellent characteristics and a smooth surface. Resinous compositions SLA offer a wide range of optical, mechanical and thermal properties that correspond to the properties of standard, technical and industrial thermoplastics.

SLA is a great option for high-precision prototypes that require rigid tolerances and smooth surfaces, such as forms, patterns and functional parts. SLA is widely used in various industries: from mechanical engineering and design of products to production, dentistry, jewelry, creating models and education.

Comparison of 3D printing technologies FDM and SLA. Quality and print accuracy. When the processes of 3D printing create parts layer by layer, each layer also makes inaccuracy. The process of forming layers affects the quality of the surface, the level of accuracy and, therefore, the overall quality of printing.

FDM 3D printer's layers may not fully stick to each other, layers, as a rule, are clearly visible on the surface, and in the process there is no ability to reproduce complex, small details that other technologies can offer.

In SLA 3D printing, allows you to get smaller parts and is more reliable for multiple achievements of high-quality results. As a result, SLA 3D printing is known for its excellent characteristics, a smooth surface, the highest accuracy of details.

Using light instead of heat for printing is another way for SLA machines to guarantee reliability. When printing parts are at a temperatures close to room temperature, they do not suffer from thermal expansion and artifacts compression that may occur during FDM printing.

While FDM creates a mechanical connection between layers, SLA 3D printers create chemical bonds by transverse stitching of photopolymers between layers, resulting in completely dense, waterproof and airtight parts. These bonds provide a high degree of lateral strength, which leads to isotropic details. Which means that the ruggedness of the parts does not change with the orientation. It makes SLA especially ideal for mechanical engineering and production, where the properties of the material are important.

Materials. FDM 3D printers work with a number of standard thermoplastics, such as ABS, PLA and their various mixtures. The popularity of FDM in space for lovers led to abundance of color options. There are also various experimental mixtures of threads to create parts with a surface similar to a tree or metal.

Engineering materials such as nylon, PETG, PA or TPU and high-performance thermoplasty, such as PEEK or PEI, are also available, but are often limited to elected FDM professional printers that support them.

SLA resins have the advantage of a wide range of configurations of the compositions: materials can be soft or solid, strongly filled materials, such as glass and ceramics, or filled with mechanical properties, such as high heat deviation temperature or impact resistance. Various resin compositions offer a wide range of optical, mechanical and thermal properties to comply with the properties of standard, technical and industrial thermoplastics.

Description and Specifications of 3D printers

Premier3D N1 3D Printer (FDM)

Pic. 1. – 3D printer Premier3D N1

The impressive size of the print area, components of the 200x200x200 mm. Together with a compact case and low weight, will allow the use of Premier3D N1 at home without any problems without any limiting space.

The print speed is impressive being 70 mm / s with the thickness of only 0.1 mm. Such productivity was achieved by applying special print head algorithms. The LCD panel responsible for setting up the printer has high informativeness and a large number of functions, allowing you to configure Premier3D to print any models using the necessary type of plastic [1].

Table 1. – Technical characteristics

The main	
Type	FDM printer
Minimum layer thickness	100 mkm
Technical characteristics	
Print area length, width, height	200 mm
Supported materials	PLA, ABS
Material thickness	1,75 mm
Table temperature	60 –$120^{\circ}C$
Extruder temperature	190 – $260^{\circ}C$
Maximum print speed	70 mm/s
Dimensions and weight	
Length, width, height	480x505x450 mm
Weight	19,9 kg

3D Printer Stratasys Mojo (FDM)

3D printer Mojo from Stratasys is a reliable and fast three-dimensional printing system that will easily fit on your desk.

Pic. 2. – 3D printer Stratasys Mojo

Easy to use and high-quality in the results – the MOJO printer is specially created for quick printing prototypes using a durable ABSplus plastic. The low cost, reliability and simplicity of use make Mojo an example of an available 3D printer with good characteristics. This is the best choice for those who want to get acquainted with the capabilities of three-dimensional printing. Printer's work technology – FDM is the most popular 3D printing technology in the world. The stability of printing results also provides advanced software and automatic temperature control inside the construct chamber. This will allow you to get high-quality high-definition prototypes without leaving the workplace [2].

Table 2. – Technical characteristics

Printing technology	
FDM	layered applying molten plastic thread
Working chamber size (the size of the construction area)	
Length, width, height	127 mm
Printing options	
Material thickness	0,178 mm
Print mode	adjust
Parameters of printing block	head – 1; nozzle – 2
Color printing support	9
Supported materials	
Total	1
Materials	ABSplus-P430
Model support material	SR-30 Soluble
Cartridges	2 coils (655 sm^3)

3D Printer Form3 (SLA)

Form 3 uses low power stereolithography technology (LFS) with a flexible tank and linear illumination, which provides impeccable print quality and printer reliability. The parabolic mirror ensures that the laser prints perpendicular to the plane, providing uniform print quality throughout the platform [3].

Pic. 3. – 3D Printer Form3

Form 3 constantly monitors printing performance, built-in sensors help to maintain ideal conditions and send the printer status alerts. Optical sensors constantly adjust the scale and power, and can even detect dust. The automated resin feed system allows you to print more products and leave less used materials, as well as increase the lifespan of the bath for printing. Printing chamber with air auto-heating is up to 35 ° C.

Table 3. – Technical characteristics

The main	
Type	SLA printer
Case	closed
Minimum layer thickness	25 mkm
Technical characteristics	
Print area length, width, height	145x145x185 mm
Positioning accuracy X, Y, Z	25 mkm
Supported materials	Photopolymer
Power consumption	220 W
Management	Touch display
Interfaces	USB, Wi-Fi, Internet
Supported file formats	.stl, .obj
Laser power	250 mW

3D Printer Mass Portal Pharaon

The quality of 3D printers Mass Portal is both the quality of their assembly, ensuring reliability and uninterruptedness and quality, and the accuracy of work, which gives the best printing results, allowed them to spread across multiple continents and attract well-deserved attention to themselves.

The feature of the XD series, which represents XD 20, XD 30 and XD 40 – the ability to print multiple materials at the same time [4].

Pic. 4. – 3D Printer Mass Portal Pharaon

More about them all – in the table below. There are also prices in the table, but they are approximate – the price of any 3D printer can both grow and decrease, accurate better to learn on the site.

Table 4. – Technical characteristics

The main	
Type	FDM printer
Minimum layer thickness	10 mkm
Technical characteristics	
Print area length, width, height	300x300x300 mm
Positioning accuracy X, Y	6 mkm
Positioning accuracy Z	5 mkm
Supported materials	PLA, ABS, PVA, Nylon, PET, HIPS, FLEX, PC, TPU, PP, PETG
Material thickness	1,75 mm
Table temperature	120°C
Extruder temperature	300°C
Supported file formats	.stl, .obj, gcode
Interfaces	USB, Wi-Fi, Internet
Power consumption	360 W
Complete set	
Nozzle	0,1 – 1 mm
Dimensions and weight	
Length, width, height	480x505x450 mm
Weight	19,9 kg

Conclusion. In the process of analyzing 3D printers based on FDM, SLA, we revealed their differences. The effect of the printer based on the temperature of the extruder, the heating of the table, power consumption, supported materials, the influence of various factors on the print speed. We also studied the thickness of materials, the minimum thickness of the layers. The dimensions of each printer, the size of the print area have been analyzed. The print area of the printers under consideration based on FDM is from 145 to 300 mm, and the printer based on SLA is significantly less than 127 mm. In printers operating on FDM technology, the minimum thickness of the layer is 100 mm, when based on SLA – 127 microns. There is also a difference in printing technology. 3D printers FDM form layers by applying molten plastic lines. In this process, the resolution of the part is determined by the size of the extruder. In the process of analyzing 3D printers based on FDM, SLA, we revealed their differences. In this process, the resolution of the part is determined by the size of the extruder nozzle, and voids occur between the rounded lines when the nozzle is precipitated. In SLA 3D printing, the liquid resin is cured by a high-precision laser for the formation of each layer, which allows you to get smaller parts and is more reliable for repeatedly achieving high-quality results.

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