

## MODERN 3D PRINTING TECHNOLOGIES OF PRODUCTS AND PARTS

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**Introduction.** Active development of 3D printing technologies is currently observed. The aim of this research project is learning existing methods of 3D printing for following analysis and use in modern mechanical engineering. 3D printing is a promising area for research because appeared relatively recently [1].

**Research results.** At the moment, you can divide all existing methods of 3D printing into three categories:

1. LS (Laser Sintering), based on laser technologies;
2. HP (Heating Printing), based on material heating;
3. Basic, based on glued powder printing;

**Basic. 3DP (three-dimensional printing).** Glue is applied to the material in powder form, which binds the granules, then a fresh layer of powder is applied over the glued layer, etc. In the end, as a rule, it turns out material sandstone (similar in properties to gypsum).

[LS - Laser Sintering](#)

Figure 1. – Laser sintering

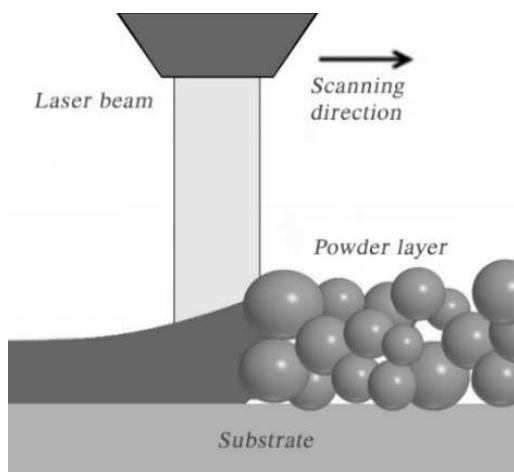


Figure 1. – Laser sintering

**SLS – selective laser sintering.**

The basic principle of operation is to spray a multi-colored hardener onto a thin layer of fine powder in predetermined areas. This procedure is repeated many times, and as a result, the necessary element is formed. It should be noted that the layers are so thin that they are visible under the previous ones. As a result of the increase in the number of layers, the bottom of the tank gradually drops down. The time of receipt of the finished product directly depends on the complexity of the execution of the object itself.

**SLA - laser stereolithography**

The principle of the operation of this technology is the action of a laser, UV (ultraviolet) or IR (Infrared) on a photopolymer (liquid). As a result, the liquid is converted to a fairly hard plastic.

Platform deepens in liquid polymer, then the beam passes through the liquid layer under the platform, that leads to hardening and sticking it to the platform, thus, a single layer is created. As a result of repeating such a procedure many times the necessary layout is formed.

**LOM - laminated object manufacturing**

Thin laminated sheets of material are cut with a knife or laser, and then sintered or glued into a three-dimensional object. That is, a thin sheet of material is laid, which is cut out along the contour of the object, thus one layer is obtained, the next sheet is laid on it, and so on. After that, all sheets are pressed or sintered.

**SL – stereolithography**

There is a small bath with liquid polymer. The laser beam passes over the surface, and in this place the polymer polymerizes under the influence of UV (ultraviolet). After one layer is ready, the platform with the part is lowered, the liquid polymer fills the void, the next layer is baked, and so on. Sometimes the opposite happens: platform with the part rises up, the laser is respectively located below ...

After printing by this method, the object requires post-processing - removal of excess material and support, sometimes the surface is ground. Depending on the required properties of the final object, the model is baked in the so-called ultraviolet ovens.

Photopolymer is often toxic therefore, when working with him, you need to use protective equipment and respirators.

#### **Polyjet**

Photopolymer shoots in small doses from thin nozzles, as in inkjet printing, and immediately polymerizes on the surface of the manufactured device under the influence of ultraviolet radiation. An important feature that distinguishes PolyJet from stereolithography, is the ability to print various materials.

#### **LENS - laser engineered net shaping**

Material in powder form is blown from the nozzle and arrives at the focused laser beam. Part of the powder flies past, and the part that falls into the laser focus instantly sinter and layer by layer forms a three-dimensional part.

#### **DMLS - direct metal laser sintering**

Powdered metal consumable enters the working chamber in a volume necessary to printing one layer. A special roller smoothes the powder equally over the entire surface, while removing excess from the chamber. The laser sinters the fresh material with the existing layer according to the original model (picture 1). This process continues until the printing of the part is complete.

#### **HP - Heating Printing (Ошибка! Источник ссылки не найден.)**

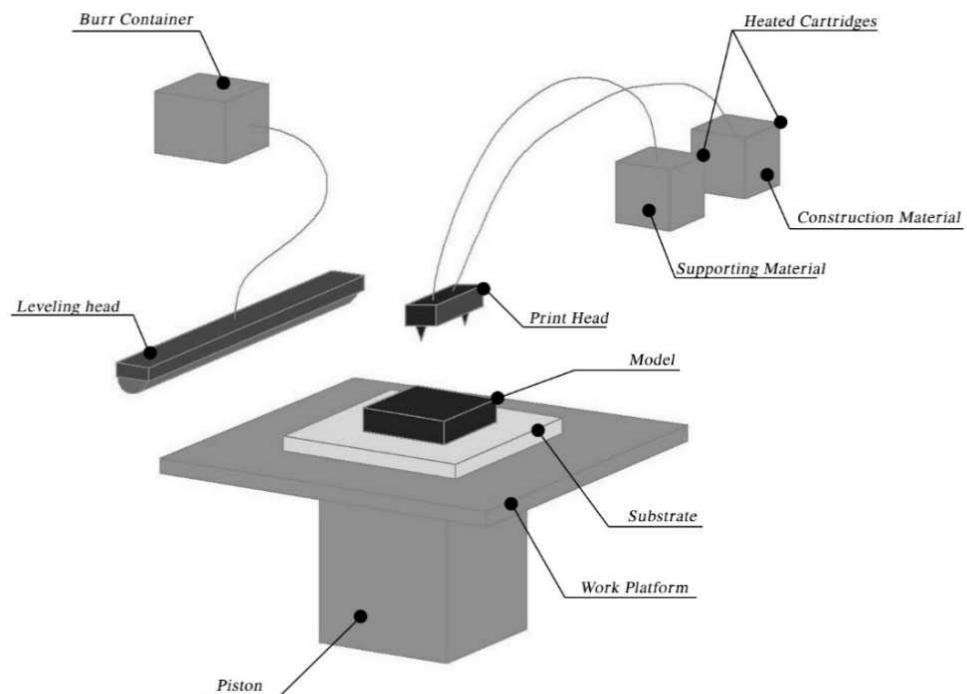


Figure 2. – Heating Printing

#### **MJM - multi jet modeling**

In this method, the light curing of the polymer is carried out through the influence of UV (ultraviolet) flash. The molten acrylic photopolymer (plastic) is applied to the printing platform using the head. On this platform, the plastic lends itself to being illuminated by a halogen lamp, resulting in hardening of the material. The procedure is repeated many times to achieve the desired result. An important detail is the supporting of protruding or overhanging parts, which is carried out using household wax.

#### **DLP - digital light processing**

DLP is quite similar in its technological process to MJM (multi jet modeling). A clear difference is the effect of the projector on the model with the usual light flux to obtain polymer cure. The photopolymer is added to the cell as it is consumed. During the printing process, the machine closes to prevent the model from flashing.

The protruding parts are also supported by the use of wax. Which removal technology is the same.

#### **FDM - fused deposition modeling**

FDM is the creation of inkjet technology. Using this technology, the printer operates directly from plastic coils tucked into the extruder. The main principle of work is the melting of a plastic rod, the formation of a drop from it and applying it to a moving platform in a given place.

#### **EBM - electron beam melting**

Additive manufacturing method similar to selective laser sintering (SLS), but using a high-energy electron beam in vacuum instead of a laser. As with SLS (selective laser sintering), the consumable for EBM (electron beam melting) is typically a powder pulverized to a powder consistency using ball mills. As a material, titanium, alloys based on it and some steel grades are usually used.

#### **DIW - direct ink writing**

Robocasting is an additive technology that implements layer-by-layer 3D printing of an object by extrusion of "ink" through the forming hole of the head of a 3D printer. "Ink" comes out of the nozzle in a liquid state, but immediately takes the desired shape due to its plasticity. This distinguishes robocasting from fusion modeling, since it does not require hardening or drying of the "ink", they immediately take the desired shape.

#### **EBF - electron beam freeform fabrication**

The manufacture of electronic forms in vacuum by electron beam melting, where a wire of one or another metal is used as a consumable material. It is carried out by analogy with EBM (electron beam melting), and the difference is that the metal is fed into the electron beam melting zone, as was said, in the form of a wire, not a powder.

#### **SHS - selective heating sintering**

Melting layers of thermoplastic or metal powder by thermal radiation. The peculiarity of the method is that all layers are baked immediately, since the radiation enters through a special mask, which directs heat to those points where it is necessary to fix the layer.

#### **DED - directed energy deposition**

One of the additive processes, according to which building material and energy for its fusion are supplied simultaneously to the place of construction of the product.

Powder material using a special device is spread out in a thin layer of the order of several tens of microns on the installation desktop in accordance with the obtained 3D model. And this happens almost simultaneously with sintering. In other words, a layer of building material is not formed here, but the material is fed to a specific place where energy is currently being supplied and where the process of forming the part is going on. Just as the welder introduces the material (electrode) to the place where the melt zone is formed due to the electric arc.

#### REFERENCES

1. Using of 3d modelling and rapid phototyping technologies during the design of constructions of block-module surface cuttings/ S. Portsianko, N. Popok - Materials of IX junior researchers' conference. Part 3 - Novopolotsk, PSU, 2017, p.214-215.