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THE STRUCTURE, STRUCTURE AND APPLICATION OF 3D PRINTER FILAMENTS: ANALYSIS AND PROSPECTS

Dotsent. ***Tokhtasheva Maloxat Nafasovna***
(Tashkent Institute of Chemical Technology)
m.tukhtasheva@tkti.uz
Erkinov Ahiyor Komiljon ugli
(Tashkent Institute of Chemical Technology)
a.erkinov@tkti.uz

Annotation: In this article the composition, structure and areas of application of 3D printer filaments are analyzed qilinadi. 3D the development of printing technology and its application in various industries are related to the physicochemical properties of these materials. In addition, prospects of new innovative filaments and their importance in industry and research are examined.
Key words: 3D printer, filament, thermoplastic polymer, composite material, biodegradation, PLA, ABS, PETG, TPU, Nylon, innovative material, industrial application.

In recent years, 3D printing technology has brought about revolutionary changes in the fields of industry, medicine, engineering, design, and education. This technology allows for time and cost savings, thus simplifying the production process of products. And the success of 3D printing depends to a lot on the materials used, especially the composition and structure of the filaments determines the quality of the process.

3D printer filaments are made of a variety of polymer and composite materials, each of which has its own specific physical and chemical properties. The use of different materials also determines in what areas they will be used. For example, in the engineering and automotive industry, where high durability is required, materials such as ABS and Nylon are preferred, while for eco-friendly and biodegradable products, materials such as PLA are preferred. In addition, elastic and flexible materials play an important role in the manufacture of dentures and orthopedic products.

This article examines in detail the structure and structure of filaments of 3D printer and analyzes their potential applications in various fields. The focus will also be on prospects for the future and directions for the development of new innovative materials.

Structure and Structure of 3D Printer Filaments

The filaments used in 3D printers are made from a variety of materials, and each has its own unique characteristics. In order to understand the composition of the filaments, their basic polymer components and additives are analyzed. Filaments are divided into the following main categories:

Thermoplastic polymers are materials that can be processed and melted. This category includes materials such as PLA, ABS, PETG, TPU, and Nylon.

Composite materials – filaments with which carbon fibres, glass fibres or metal particles are added to base polymers. They provide added durability and mechanical durability.

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Biodegradation polymers – environmentally friendly, are characterized by the characterization of biodegradation in natural environments (e.g. PLA and PHA (Polyhydroxyalkanoates)).

Each type of filament is distinguished by its physicochemical properties:

PLA (Polylactic Acid) is an eco-friendly filament derived from natural sources (corn starch). It is famous for its low temperature melting and easy printing. But brittleness and resistance to low temperatures is one of its drawbacks.

From Wikipedia, the free encyclopedia It has good heat resistance and is widely used in industrial and automotive parts manufacturing. But it requires good ventilation, due to the release of harmful fumes during the printing process.

PETG (Polyethylene Terephthalate Glycol-modified) is a material that embodies the properties of ABS and PLA. It is considered durable, elastic and safe for contact with food.

TPU (Thermoplastic Polyurethanhane) is an elastic and flexible material that is used for products requiring a loose structure (e.g. phone cases, sports equipment).

Nylon – widely used for industrial products due to its high temperature resistance and strong mechanical properties. It is distinguished by its stance and tendency to overcupeering.

A scientific approach to the structure of polymers

Filaments may have a structurally amorphous or partially crystalline state. Amorphous polymers (PLA, ABS) have an irregular molecular structure which provides good elasticity and softness. Whilst partial crystalline polymers (Nylon) have an orderly molecular structure and provide high mechanical consistency and heat resistance.

Also, plasticizers, stabilizers and pigments are added to the filaments, in order to improve their mechanical and chemical properties. For example, filaments enriched with carbon fibre can be 30 to 50% stronger than conventional polymers.

Physicochemical properties of filaments

The physicochemical properties of filaments depend on their structural structure, and have the following main parameters:

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Melting temperature – determines at what temperature the filament melts and is deposited in layers during 3D printing. For example, PLA melts at 180-220°C, while ABS melts at 230-260°C.
Strength and elasticity – determines the mechanical strength of the final product. For example, Nylon has a high consistency, while TPU is characterized by high elasticity.
Chemical resistance – it is necessary that a material must be resistant to various chemicals. For example, PETG has high chemical resistance.
Moisture sensitivity – Some filaments, especially Nylon, can absorb water and lose their properties. Therefore, they should be kept in dry conditions.
Environmental safety – some filaments are biodegradable under natural conditions, while others require processing.
Heat resistance – The high temperature resistance of filaments determines the application in industrial areas. For example, ABS is suitable for high-temperature environments.
Each of these properties has a direct impact on the quality and uptime of the printed object. Therefore, the selection of a suitable filament for each application is of great importance.

Fields of application of filaments

The field of application of filaments depends on their physicochemical properties and are widely used in the following main areas:
Industrial and engineering – ABS, Nylon and composite filaments are used in the manufacture of parts for which high strength and durability are required.
Medical – biocomplementary and sterilization-resistant materials are used in the manufacturing of medical implants, prostheses and orthopedic devices. For example, PLA and PEEK are widely used for medical purposes.
Automotive industry – durable and light materials are used in the production of automotive parts, aerodynamic components.
Electronics and robotics – filaments with insulating properties are used in the production of electronic devices and protective coatings.
Ecological products – biodegradable filaments (PLA, PHA) are used for environmental conservation purposes.
Choosing the appropriate material for each area will help improve the product's performance and durability.

Conclusion

The composition, structure, and physicochemical properties of 3D printer filaments have a direct influence on their application in various industrial applications. The various properties of filaments such as strength, heat resistance, environmental friendliness, and flexibility allow for their wide application.
Materials such as biodegradable PLA are used in the manufacturing of eco-friendly products, while the high strength ABS and Nylon are used in engineering as well as the automotive industry. PETG and TPU, on the other hand, are distinguished by their chemical and mechanical resistance and are widely used in industry and everyday life.
In the future, the development of new generation of filaments, including biomaterials, nanoparticle-enhanced composites and materials with variable properties, is expected to further expand the possibilities of 3D printing. Therefore, further processing of this technology and the development of new innovative materials remains an important direction in scientific research.

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