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EFFECT OF FILLERS ON POLYMERS

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ABSTRACT

The article provides information on the types of mineral (inorganic) and organic fillers, methods of production, physicochemical properties and the role of these fillers in secondary polymer waste, the prospects for their widespread use in engineering.

Keywords: *Mineral, fine, medium, monofilament, single crystal, metal, fiber, coke, graphite, flour, powder, synthetic, polymer, fluoroplastic, carbon black*

АННОТАЦИЯ

В статье приведены сведения о видах минеральных (неорганических) и органических наполнителей, способах их получения, физико-химических свойствах и роли этих наполнителей во вторичных полимерных отходах, перспективах их широкого применения в технике.

Ключевые слова: *тонкодисперсными, среднедисперсными, моноволокна, монокристаллов, металл, волокна, кокс, графит, мука, порошкообразные,синтетические,полимеры,фторопласт, сажа.*

INTRODUCTION

Minerals can be fine (5 microns), medium (50) and coarse (up to 500). Mineral fillers can be, also fibrous, which are inferior in assortment to dispersed ones. The most common among them are glass and carbon fibers, cotton and synthetic fibers, as well as waste from their production, and monofilaments in the form of single crystals, oxides of metals and metalloids. The fibers can be chopped and continuous in form. organic - wood flour, nutshell flour, soot, (carbon black), coke, graphite and others. From organic dispersed: other flour, powdered synthetic polymers: finely dispersed fluoroplastic [3].

Technical carbon.

It is the most widely used electrically conductive filler. X-ray studies of soot particles showed that they consist of individual small crystalline cells built like granite. The arrangement of carbon atoms in the layer is the same as in graphite, and the distance between the layers is greater than in graphite crystals. The places where the ends of the parallel layers come out to the surface of the particles have an increased energy and, consequently, a greater adsorption capacity. It is this that determines the ability of soot particles to form chains and network structures - this property is called soot structuredness. The active site on its surface can also adsorb foreign components (for example, oxygen), their presence worsens the “soot structuredness” [4]. For this reason, the electrical conductivity of carbon black generally increases with decreasing concentration of volatiles. Another factor that determines the conductivity of soot is the specific surface area, which depends on the size and porosity of the particles [5].

DISCUSSION AND RESULTS

Thus, carbon black - soot should have the following properties: large specific adsorption surface, high porosity, small particle size, low content of volatile impurities, high degree of structure.

There are 3 allotropic modifications of carbon:

diamond, graphite and carbine. But the most stable of them are C_{60} and C_{70}. They are in the form of a closed surface. Subsequently, others began to be called fullerenes, in honor of the American architect and inventor who received a patent for building structures in the form of fragments of polyhedral surfaces that can be used as roofs of large buildings. Scientists have discovered for the first time that C_{60} molecules can form solid crystals - a new crystalline allotropic modification of carbon - fullerite. It turned out that the density of fullerite is 1.7 g/cm3, i.e. the loosest modification of carbon. Currently, there are also nanofillers - these are particles that are dispersed to sizes commensurate with the size of polymer macromolecules, that is, with a nanorange from one to several tens of nanometers: nanocarbon (soot), nanonickel, nanosilicon and a number of other new additives. Nanofillers are actively involved in the chemical and physical processes of formation and structuring of polymers, significantly affecting the mechanism of formation of the properties of plastics. Their share in plastics is up to 1% [6].

Filling is a combination of polymers with solid, liquid or gaseous substances, which are relatively evenly distributed in the volume of the resulting composition and have a clearly defined interface with the continuous polymer phase (matrix).

Filling is one of the main ways to create composite materials, rubbers, adhesives, compounds, paints and other materials with specified technological and operational properties. Filling and reinforcing polymers are as old as these materials themselves.

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By belonging to the class of compounds, fillers are divided into mineral and organic. The mineral group includes such as asbestos, mica, quartz flour, talc, fiberglass and others. Among the most famous are wood flour for phenolic resins, carbon black (soot) for rubbers [7].

When developing plastic formulations, the following questions need to be answered:

• What is the property gain to be achieved?
• What undesirable changes might occur?
• How easy is the filler to handle and how can it affect the process?
• What is the real cost of the filler?

In most cases, a plastic modified with functional fillers is more expensive than a polymer matrix. This is due to the often expensive way of filling; the higher cost of stabilizers, the need to use special additives and, finally, the increase in processing and logistics costs compared to unfilled polymers. Since the specific gravity of most fillers is significantly higher than the specific gravity of polymers, the specific volume of the composition decreases, which leads to an increase in costs and the end user, who purchases raw materials by weight and sells the finished product of a certain volume. The choice of the optimal filler is very important and depends on the properties required in the finished product or semi-finished product .

Table 1.

Filler	Carbonate Ca	Talc	Kaolin	Wollastonite (metasilicate Ca-white, acicular) powder)	Other additives
amount, %	66	6	6	3	19

Volume of world consumption of fillers for 2020.

Fillers, when introduced, can affect almost all properties of polymers: surface quality, color, density, shrinkage, thermal expansion coefficient, conductivity, permeability, and mechanical and thermophysical properties. The presence of filler particles inside the polymer matrix can affect the crystallinity and glass transition temperature, that is, it can cause hampered conformational movement of the molecules [8]. However, in most cases, when developing compositions, they strive to improve the mechanical and thermophysical properties [9]. There are a number of equations describing the dependence of the properties of compositions on the parameters of the filler. The stiffness of the composition is affected by the elastic modulus of both the filler and the polymer matrix, the filler concentration, the filler form factor, the packing factor, the interaction of the polymer and the filler, and the orientation of the particles in the polymer matrix. Typically, as the stiffness increases, the composition becomes more brittle and, as a result, the impact strength deteriorates. The impact strength of the composition is highly dependent on the presence of large particles, since they can act as microcracks. Requirements for fillers.

• good wettability with liquid polymer:

• the ability to combine with the polymer to form a homogeneous mass (for dispersed fillers), the filler should not be abrasive;

• retain its structure and properties unchanged during storage and processing;

• it should be easy to handle, it should have high bulk density, low moisture content, low dustiness, and be non-toxic.

• The filler must be available in sufficient quantities at reasonable prices and of consistent quality.

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