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Polymer Composites Based on Natural Minerals with Different Compositions and Their Strength Indicators

Jafarov Valeh Jabbar *, Alimirzaeva Nahida Amanulla, Nurullaeva Dilbar Rushan, Bektashi Sevil Aligeydar, Rajabova Mansura Jamal, Musaeva Gulnara Huseynchan and Khalilova Sanam Musa

Institute of Polymer Materials Ministry of Science and Education of the Republic of Azerbaijan, S. Vurgun Street, 124, Sumgayit AZ5000, Azerbaijan; nahidalimirzayeva@gmail.com (A.N.A.); ndilbar@list.ru (N.D.R.); bektashisevil@gmail.com (B.S.A.); mrecebova71@gmail.com (R.M.J.); movlanrewid77@gmail.com (M.G.H.); khalilova.leyla@inbox.ru (K.S.M.)

* Corresponding author. E-mail: valeh-ani@mail.ru (J.V.J.)

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ABSTRACT: The presented scientific research work is dedicated to solving the problem of obtaining polymer composite materials with various superior operational properties based on polyolefins and a number of natural mineral rocks characterized by their corresponding characteristics, and investigating the application possibilities of the created materials. In this regard, local natural mineral resources are prepared for research in laboratory conditions through technological processes and mixed with a polymer matrix using a physical-mechanical method. The resulting mixture is brought to a ready state for research and is introduced into the process. Composite samples created on the basis of polyolefin and mineral rock are sent for research in accordance with different ratios of the components that make up the composite. The goal is to find the optimal ratio and determine the material that reflects higher quality criteria. Research conducted in this direction has yielded positive results. Research work that meets the requirements of modern chemical science can be considered satisfactory from an ecological and economic perspective.

Keywords: Natural mineral rock; Clay; Filler; Tensile strength limit (σ); Relative elongation (ε); Alloy flow index

1. Introduction

One of the priority areas of modern chemical science is the production of new materials of various compositions and properties based on polymers and their additives. The nature, structure and properties of the filler added to the primary polymer are important factors in obtaining any polymer composite and creating a new material with higher properties.

The implementation of scientific and technical processes aimed at creating polymer composite materials and characterizing a number of their characteristic properties can be considered a perspective on the way to obtaining a number of materials with superior performance properties. Taking into account all these criteria, it is logical and positive steps towards the acquisition and research of materials that carry complex quality criteria based on polymers characterized by their distinctive properties, fillers selected by their nature, and linking agents characterized by their functionality.

Currently, work on obtaining materials based on natural mineral fillers and polyolefins has gained wide scope and expanded the scope of interest. The issue of conducting these technological processes in a number of areas, such as materials science, catalysis, polymer modification, and obtaining various positive results, remains relevant.

It is known from the literature that small-sized modifiers, characterized by many different properties, give different specific results in the composition. In this regard, it is advisable to use a number of world scientific literature studies.

The inclusion of modifiers of various natures and forms as fillers in a polymer composition opens up wide opportunities for achieving higher results due to their high surface energy and adsorption capacity [1].

Selection and use of fillers to obtain a material with strength properties and low cost; Selection and use of plasticizers, primers and other target components to simplify technological processes and improve operational properties; Adjustment of friction and antifriction properties; Insertion of additional components to regulate thermal and electrical conductivity; Addition of appropriate fire retardants to improve combustion resistance [2].

As a result of studying the scientific literature, we see that numerous scientific studies have been conducted over many years to obtain composites filled with modifiers, and positive results have been achieved.

Fillers are made from natural mineral components—clay, zeolites, *etc.*, and have a number of advantages over other types of fillers.

- One of the main advantages of mineral fillers is their ability to absorb moisture. This helps eliminate odors, maintain cleanliness in the tray, and ensure dryness on the surface.
- Due to their natural origin, the materials are considered one of the most environmentally friendly fillers;
- Affordable price and has a long service life.
- Mineral fillers are usually heavier than wood or silica gel. This can create inconvenience during transportation and disposal of used filler.

Traditional polymer composite materials consist of two or more phases with the appropriate interphase boundary, which have the physical and mechanical properties of existing plastics. The properties of composites modified with nanosized fillers depend on many parameters: the chemical nature of the polymer, the functionality of the modifier, the methods of obtaining the composite and the modification of the layered silicate.

Silicates are the most widespread class of minerals. The nanostructured surfaces of such materials have very low adhesion energies due to their special relief, which causes the products to acquire dirt-repellent properties and improve their appearance and consumer qualities. In addition, the permeability of the material to gases, vapors and odors is significantly reduced [3].

The issue of using polyolefins such as polyvinyl chloride, polyethylene, polyformaldehyde, polytetrafluoroethylene, *etc.*, as a polymer matrix is considered relevant in science as a promising direction. They increase the chemical resistance of the material and, together with other dispersed and fibrous fillers, improve its wear resistance, friction coefficient and dielectric properties. During the production and processing of PCMs, their strength increases and they are retained as free phase particles, significantly increasing their efficiency [4].

Bio-polymer composites are emerging as a feasible substitute for conventional polymers in various major fields of application. In the current research, the impact of hybridization of inter and intra-woven natural engineering fibers, namely, brown flax, white flax, and jute of different amalgamations, along with commingled SCF and novel nano IW filler, has been studied. The composites are manufactured by a hand layup process and physical and thermomechanical characteristics of the composites are experimentally studied. The composites mingled with IW filler demonstrated better dimensional stability and mechanical properties such as maximum tensile strength of 36.74 MPa, bending strength of 82.53 MPa, and hardness of 84.89 D compared to other composites. However, elastic and flexural modulus are maximum for composite without any filler. The composites mingled with SCF filler demonstrated the highest impact strength, energy absorption, and elongation. Thermogravimetric analysis and thermal conductivity study demonstrated that the composite with SCF filler exhibited better thermal stability and thermal resistance than the other hybrid composites [5].

Carbon fibres are the most common fibers in nature and for implementing technological processes. Carbon fibers have an extremely high heat resistance: when exposed to temperatures up to 1600–2000 °C in the absence of oxygen, the mechanical properties of the fiber do not change, which proves the possibility of their use as heat-insulating materials and heat shields in high-temperature technology. These fibers are resistant to aggressive chemical environments, but oxidize when heated in the presence of oxygen. Their maximum operating temperature in air is about 300–370 °C. Applying a thin layer of silicon carbide or boron nitride to carbon fiber significantly increases the operating temperatures in the air atmosphere. Due to its high chemical resistance, carbon fiber is used to soften harsh environments, make protective suits, and purify gases. Changing the heat treatment conditions allows you to obtain carbon fibers with different electrical properties and use them as electric heating elements. Carbon fiber activation allows obtaining a material with a large active specific surface area (300–1500 m^2/g), which allows increasing adhesion to the matrix. Due to the low density (1.7–1.9 g/cm^3) and specific strength (the ratio of strength and modulus to density), the mechanical properties of the best carbon fibers exceed all known heat-resistant fibrous materials. Carbon-carbon composites with high ablative resistance have been obtained based on carbon fibers. However, the specific strength of carbon fibers is inferior to the specific strength of fiberglass and aramid fibers. Structural carbon fiber reinforced plastics are obtained on their basis using polymer binders [6].

The results of computational and experimental studies on the effect of electrically conductive carbon black (CB) on the elastic modulus of composites based on linear low-density polyethylene (LLDPE) are highly appreciated. The study was carried out in the form of a cell with a single filler particle, a cell with randomly distributed filler particles, a composite with randomly distributed agglomerates, and the macro level of the composite [7].

Cement-containing compositions were prepared in accordance with the appropriate proportions of the components. In carbonate and dehydrated aluminosilicate rocks, % clinker is present. The objects of the study are composite cement using dehydrated clay and dolomite, aluminosilicate rocks of the Belarusian deposits—"Danilovtsy", "Lukoml", "Kustikha", dolomite carbonate rocks of the "Ruba" deposit. The activity of dehydrated clays was determined. It was clarified that dehydrated clay from the "Lukoml" deposit has the highest pozzolanic activity. The main physical and mechanical properties of the developed compositions of composite cement were determined: specific surface, standard consistency, setting time, and water separation. It was determined that the composition, wt. %: clinker—76.8; gypsum—3.2; anhydrous clay—10; dolomite—10. In the hardening system containing carbonates and aluminosilicates, calcium hydrocarboaluminate $3CaO \cdot Al_2O_3 \cdot CaCO_3 \cdot 12H_2O$, calcium hydrogen carbonate, calcium carboaluminate, and potassium hydrocarbonate solutions are formed. hydroxoaluminate composition $3CaO \cdot Al_2O_3 \cdot Ca(OH)_2 \cdot 11H_2O$, the increase in strength can be explained by the change in the composition and structure of the hardened products due to the formation of these phases [8].

Every year, the volume of accumulated polymer waste, particularly household waste, increases, and the issues of its storage and disposal are becoming increasingly relevant. Many approaches are used to process synthetic polymers by mixing with several other (both synthetic and natural) polymers. In addition to disposal, these studies aim to impart new properties to the resulting materials. However, it is worth noting that searching for new approaches to creating biodegradable materials that could decompose under the influence of external factors into substances harmless to nature is especially important. One of the polymers of interest is polylactide, obtained from lactic acid. In terms of its properties, polylactide is close to a number of synthetic polymers, but it also has disadvantages, particularly in that it is brittle. Polylactide was plasticized using polyethylene glycol (PEG) of various molecular weights when creating new materials. Mixing was carried out under conditions of high temperatures and shear deformations at different ratios of components. To impart functionality to the materials, biocomposites based on plasticized polylactide were developed with the introduction of stabilized silver nanoparticles. Films were pressed from the obtained biocomposites for further research. Since some of the important characteristics of the materials are their mechanical and thermal properties, they were studied depending on the mass of the PEG used, as well as on the introduction and amount of silver nanoparticles. The results obtained will allow the optimal formulations of biocomposites to be selected for further study [9].

The results of research on the development of finishing intermediate layer on carbon fiber under thermoflexible matrix (polysulphone) for the purpose of increase in characteristics of the fiber itself and improvement of physical-mechanical properties of carbon plastic on its basis are presented in the article. Properties of carbon plastics based on carbon reinforcements—ELUR, UKN-2500 and UKN-5000 are given. The Influence of finishing carbon fibers on interlaminar strength and porosity of carbon plastics based on the polysulfonic binding is shown. The assessment of the efficiency of finishing compositions based on polysulphone PSF-TP, polystyrene, bismaleinimides and oligoetherakrylates is given. It is shown that for finishing carbon fibers both polymers and oligomerous structures can be used. However, the greatest effect is shown when using water-soluble oligomerous or monomeric finishing compositions, which possess increased thermal stability and have functional groups available [10].

The scientific work substantiates the choice of finishing material for blocking the surface of the active filler in the manufacture of sulfur composites. The choice of the finishing material was carried out based on its ability to form homogeneous thermodynamically stable mixtures in kerosene, estimated by the value of the Gibbs energy [11].

From a number of literary sources it is known that polyolefins are used as a polymer matrix, and this is due to the fact that they have many positive properties. Thus, its relatively low cost, environmentally friendly and safe properties, relatively low density and crystallinity make its use as a matrix relevant. There is enough scientific research to produce composites using materials of different sizes as fillers.

In the study of scientific research work in this direction, extensive scientific work was carried out at the Institute of Petrochemical Processes named after Academician Yu.G. Mamedaliyev of the Ministry of Science and Education of the Republic of Azerbaijan, composite materials were synthesized, and their properties were studied using various polyolefins and metal-containing fillers. Scientists of the Institute, engaged in large-scale scientific research, made a great contribution to the chemical science of Azerbaijan with valuable studies on obtaining environmentally friendly and safe composite materials and measuring their quality criteria [12].

Modifiers (fillers) of different compositions and natures can behave differently depending on the degree of homogeneity of the system and the characteristics of the matrix. In this regard, the work was carried out with a number of natural minerals, taking into account the source of import of fillers in terms of their diversity. Thus, the modifier is accepted as follows:

- must have high dispersion;
- must have high heat resistance;
- must be inert with respect to the polymer [13].

The filler introduced into the system undergoes various processing principles and is prepared for production as a raw material. This sequence is as follows:

* Classification
* Crushing
* Washing and separation
* Drying
* Granulation
* Implementation of the product processing process.

Fillers-modifiers must be classified and used in accordance with the complexity of the technological process, depending on the conditions of their production and the region.

Azerbaijan is a country rich in natural resources (rocks). Let us present some of them:

Perlite; zeolite; vesuvianite; copper ore deposit rock; silica gel; kaolin; alunite; bentonite, *etc.* The Laboratory of Recycling and Ecology of Polymer Materials of the Institute of Polymer Materials has been engaged in scientific research for many years using the above-mentioned natural mineral rocks as fillers for polymer composites [14].

Composite materials based on a mixture of high- and low-density polyethylenes, including additives of finely dispersed zinc oxide stabilized by a matrix of maleinized high-density polyethylene, were studied using X-ray phase analysis (XRD), differential thermal analysis (DTA) and scanning electron microscopy (SEM). An enhancement in strength, deformation parameters and thermal and oxidative stability of composites was revealed with the introduction of finely dispersed zinc oxide, which is apparently due to the formation of interfacial bonds between zinc-containing nanoparticles and components of the polymer composition [15].

The effect of nanofiller (NF) additives containing zinc oxide nanoparticles stabilized by a polymer matrix of high-pressure polyethylene obtained by the mechanochemical method on the structure and properties of metal-containing nanocomposites based on isotactic polypropylene (PP) and high-pressure polyethylene (PE) using differential thermal (DTA) and X-ray phase (XRD) analyses was studied. The improvement of strength, deformation, and rheological parameters, as well as thermal-oxidative stability of the obtained nanocomposites, was revealed, which, apparently, is associated with the synergistic effect of interfacial interaction of zinc-containing nanoparticles in the PE matrix with the components of the PP/PE polymer composition. It is shown that nanocomposites based on PP/PE/NF can be processed by the pressing method, injection molding and extrusion methods, expanding their application scope [16].

The minerals used as fillers are solid. However, the material that plays the role of a modifier can be either a liquid or a gas aggregate. When polymers are filled with gases, a polymer-foam composite is obtained; thus it is possible to reduce the density of materials or increase intramolecular pores. Filling polymers with liquid is a technologically complex process. Using liquid filler emulsions, obtaining a solid and fairly durable material as the final product is possible. A number of scientific research works have produced a new generation of composites with different ratios of components based on low-density polyethylene (LDPE) and natural mineral from the village of Gızıl Zod in the Kelbajar region. The influence of the filler on the properties of the resulting composites was studied. To improve the adhesion between the polymer matrix and the filler and obtain composites with higher physical and mechanical properties, a sizing agent is included in the system. A copolymer of heptene-1 with maleic anhydride was taken as a coupling agent (apprete). It has been established that the properties of the resulting polymer composites directly depend on various factors: the structure of the polymer matrix, the amount and dispersion properties of fillers, and the properties of the sizing agent formed and acting on the interfacial layer [17].

Enough scientific research has been conducted to develop composites and fill them with additives to improve some of their properties. The successes achieved in this direction are undeniable. For many years, the issue of adding additives to composites and obtaining positive results has been addressed in various research laboratories. Fillers are diverse both in structure and in properties. Work with existing fillers in solid and liquid form is sufficient, with numerous results [18].

2. Experimental Part

Over the years, polymer composite materials have been created based on fillers brought from different areas and undergoing certain technological processes in laboratory conditions, and on a polymer matrix. Natural mineral rocks are chopped, crushed, ground in special devices, brought to a fine state and passed through sieves corresponding to certain disperse sizes. At the end of these processes, they are mixed with the polymer matrix in various proportions by a physical-mechanical method for 20–25 min at a temperature of 120–140 °C. The resulting mixture is formed by pressing both sides into a belt shape at a certain thickness under high temperature. The product brought to the required condition for research is put into use. In order to improve the compatibility and mixing between the polymer matrix and the filler, a finish is introduced into the system. Finishes are obtained in laboratory conditions by co-polymerization of monomers characterized by a number of functionalities.

Using natural mineral rock wastes of various shapes, natures and dispersions as fillers, composite samples corresponding to the corresponding mass percentage ratios were developed and a number of properties of the created polymers were studied. Due to their stereoregular structure, low cost, and workability in a wide temperature range, polyolefins and especially low-density polyethylene were taken as the polymer matrix. The use of polymers and their processed products directly leads to the protection of the natural environment and the preservation of ecological balance. Various functional additives are added to the system to ensure compatibility between the matrix and the filler and obtain a material with superior qualities. It is known from scientific studies that the strength indicators of the system to which the apprete is added are higher. This is explained by the fact that the functional groups of the finish (binder) are formed in the interlayer spaces in the system and increase its homogeneity properties.

The following tables explain the tensile strength indicators and a number of similar physical and mechanical properties of composite samples obtained based on various fillers and finishes.

The tables show the strength of polymer composite samples treated with different fillers corresponding to the sizes of 53 and 106 mkm. The higher strength limit of the sample treated with each filler was taken. In polymer/filler and polymer/filler/sizing systems with different mass ratios, the analysis is carried out according to the principle of obtaining a higher result in samples corresponding to a certain mass ratio. High-pressure polyethylene (HDPE) or low-density polyethylene (LDPE), its derivatives and polypropylene (PP) were used as a matrix. Individual copolymers synthesized in laboratory conditions were taken as a sizing.

Table 1 shows the results are high with the natural mineral rock vesuvian and the tensile strength is at its maximum. Obtaining such a result with a filler content of 80% by weight is considered very reasonable. Obtaining samples with a higher strength limit depends on the dispersion, environment, nature, and degree of polymerization of each filler taken.

Vesuvian: mineralogical composition

$Ca_{19}MgFe_2Al_{10}(Si_{18}O_{70})(OH)_8$-vesuviant—71.3%.

$(MgAl)_6(SiAl)_4O_{10}(OH)_8$-chlorite-serpentine—28.7%.

Table 1. Strength index of composite samples with different fillers (filler-53 mkm).

№	Filler, %	Matrics, %	Appret, %	Tensile Strength, σ, MPa
1.	Vesuviane-80	PE-20	2,6-dimethylhepten-6, 3-yn-2-ol	37.4
2.	Bocsite-60	PE-40	-	12.8
3.	Kaoline-60	PE-40	(MA + ED-20)-5	15.3
4.	«Goydash»-60	PE-40	(MA + Hep.1 + Acr.acid.)-1/2/1	14.1
5.	Ceolite-60	PE-40	(MA + Hep.1 + Acr.acid.)-1/1/1	17.8
6.	Alunite-60	PE-40	-	15.3
7.	Silicogel-70	PE-30	K sold-3	19
8.	Perlite-70	PE-30	-	15.1
9.	Gadabays rock.-70	PE-30	(Hep.1 + Acr.acid.)-2/1	16.9
10.	«Zahmatk.»70	PE-30	(Hep.1 + Acr.acid.)-1/2	15.4
11.	Keramsit-70	PE-30	-	14.9
12.	Artesiane rock-70	PE-30	(MA + Hex.1)-3	15.9
13.	Vulcanic rock-70	PE-30	(Hep.1 + Acr.acid.)-2/1	13.7
14.	«Turshsu»-60	PE-40	(Hex.1 + Acr.acid.)-2/1	17.2

Looking at the evidence in Table 2, we observe that the sample with the maximum tensile strength has a component ratio of α quartz albite/RPE of 70/30%.

Table 2. Results of studies conducted with recycled polyethylene (filler-106 mkm).

№	Filler, %	Matrics, %	Appret, %	Tensile Strength, σ, MPa
1.	Dashkasan rock-70	RPE-30	(Hex.1 + Acr.acid.)-2/1	16.7
2.	Bentonite-60	RPE-40	(MA + Hep.1)-1/1	15.8
3.	α-kvars-70	RPE-30	-	31
4.	Tavus rock-60	RPE-40	Polimetacrilate-3	18.8

Tables 3 and 4 shows the physical and mechanical properties of composite materials based on polypropylene and a number of natural minerals. Here, in the sample with PP-60 and Ex. mining.indust.-40 mass percent, the strength reaches a maximum and is 33.6 MPa. This depends on both the nature and shape of the filler, as well as on a number of properties and stereoregular structure of PP.

Table 3. Results of the study conducted with polypropylene (filler-53 mkm).

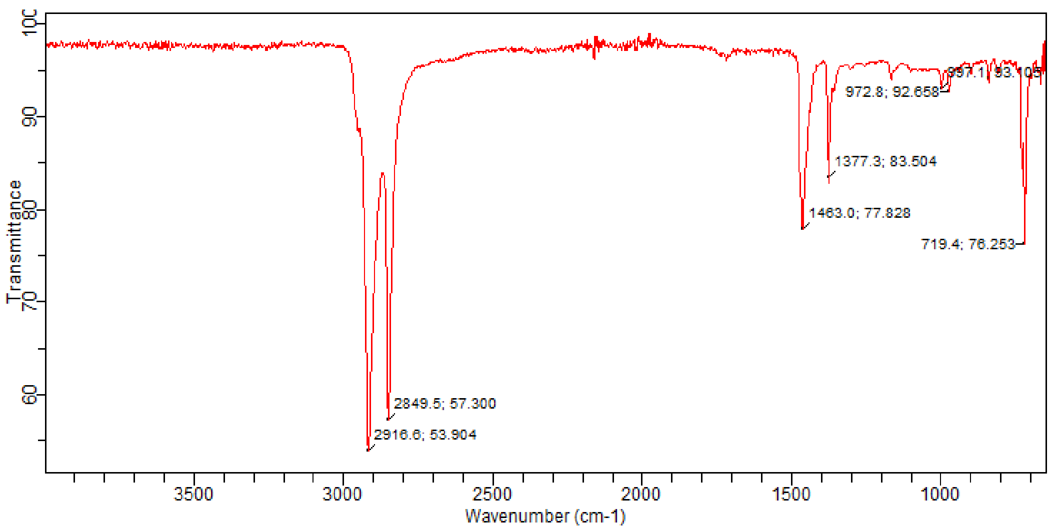
№	Filler, %	Matrics, %	Tensile Strength, σ, MPa
1.	Ex. mining indust.-40	PP-60	33.6
2.	«Gizil Zod»-30	PP-70	30.6
3.	«Damirchi Dam»-50	PP-50	32.3
4.	Vulcanic rock-30	PP-70	38

Table 4. Chemical composition of vesuvian, (%).

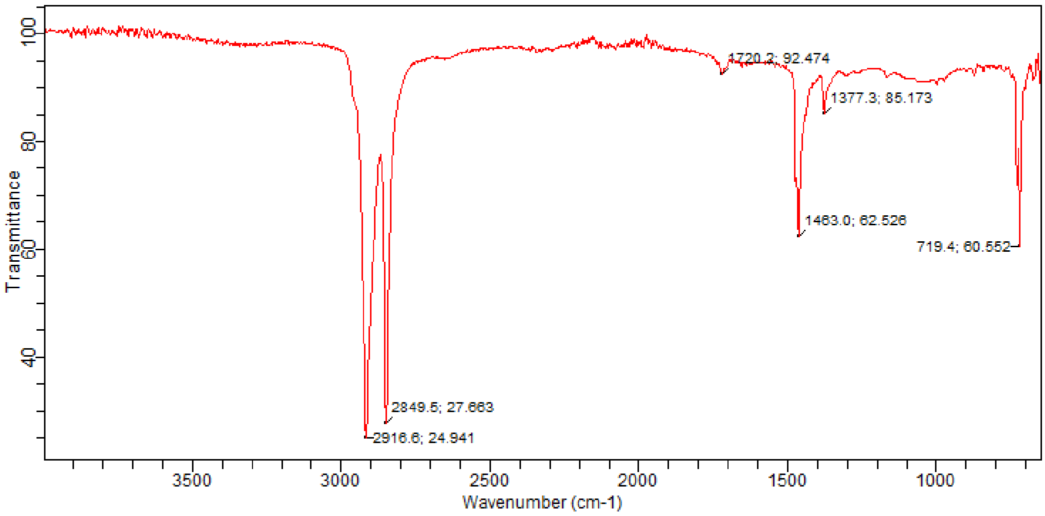
Rock Comp.	SiO_2	Al_2O_3	Fe_2O_3	MgO	Na_2O	K_2O	P_2O_5	SO_3	CaO	TiO_2
Vesuv.	36.7	15.8	4.8	3.2	0.5	0.3	0.02	0.03	30.5	0.05

Samples corresponding to the 53 and 106 mkm dispersion of the filler were analyzed by infrared spectroscopic analysis on an Agilent Cary 630 FTIR instrument (wavelength 600–4000 sm^{-1}) from Agilent Technologies, Santa Clara, CA, USA.

In the spectrum presented in the Figure 1, it was determined that the absorption bands of the filler with a dispersion of 53 mkm had stripes by giving the values.



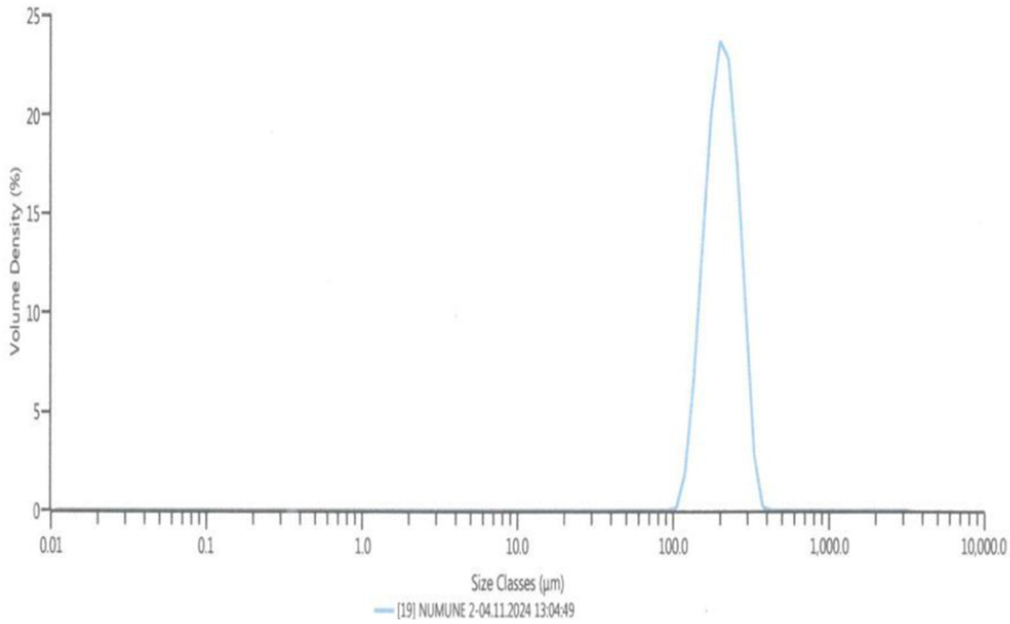
(a)



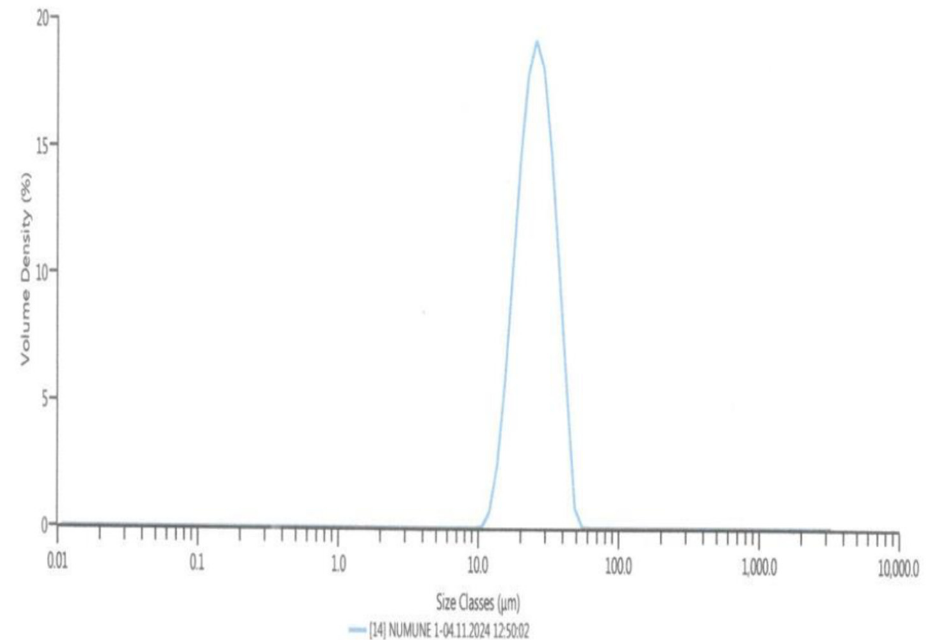
(b)

Figure 1. (**a**). Photograph of infrared spectra corresponding to a 50 mkm dispersion of the filler. (**b**). Photograph of infrared spectra corresponding to a 106 mkm dispersion of the filler.

The interval between the absorption bands in the spectra corresponding to a 50 mkm dispersion of the filler is larger than the interval between the absorption bands in the spectra corresponding to a 106 mkm dispersion. This is explained by the fact that the composite better matches the state of the components due to the denser dispersion.The corresponding indices for both dispersion sizes of the filler were determined using a Master Sizer device, and their diffractograms were determined in Figure 2.



(a)



(b)

Figure 2. (**a**). Diffractogram corresponding to a 106 mkm dispersion of the filler. (**b**). Diffractogram corresponding to a 53 mkm dispersion of the filler.

When looking at the results of graphs and Tables 5 and 6 corresponding to the dispersion rates of lizardite natural mineral rock using the Mastersizer device, it is observed that the evidence corresponding to the 53 micron size is more satisfactory. Similarly, a number of indicators of composites created with different mass percentage ratios of their components also receive high values.

The issue of determining and investigating the properties of samples corresponding to different amounts of components that make up the composite.

First, a number of indicators corresponding to the dispersion dimensions of the filler taken are analyzed.

Table 5. The diffractogram shows a lizardite reflection corresponding to a size of 106 and 53 microns. Here we present the size characteristics.

Particle Refractive Index	2.420	Span	0.613 0.782
Particle Absorption Index	0.030	Uniformity	0.189 0.235
Dispersant	Name water	Specific surface area	30.28 m^2/kg 24/69 m^2/kg
Dispersant Refructive İndex	1.330	Dv(10)	149 μm 17.2 μm
Scatlering Model	Mie	Dv(50)	204 μm 25.5 μm
Analysis Model	General purpose	Dv(90)	274 μm 37.1 μm
Welghted Residual	15.63%	Volume above(10) μm	100.00%
Laser Obscuration	0.00%	Volume below(90) μm	0.00%

Table 6. Indicators corresponding to the corresponding dispersion of the filler: (Filler-vesuvian).

№	**Particle Size, mkm**	**50**	**53**	**106**
1.	Amount of filler, %	30	40	50
2.	Tensile strength, σ, MPa	19.5	17.8	15.2
3.	Modulus of elasticity, $\bar{e}_{eff*}$ 10^{-2}	10.2	13.2	14.5
4.	Degree of crystallization, %	45	46	49
5.	Relative elongation, ε, %	10	20	25

It can be seen from the table that in the sample corresponding to the dispersion of the filler of 50 μm, the tensile strength limit is high and is σ = 19.5 MPa. In this regard, the study was conducted precisely according to the dispersion of the filler of 53 mkm.

The values of the parameters obtained from the corresponding process based on experiments are given in the table.

(a) Without the presence of a binder
(b) With the presence of a binder

Thus, the selected processed isotactic polypropylene, 50 μm filler-vesuvian and synthesized binder-polyacrylate were mixed, and samples corresponding to different mass percentage ratios were processed and their properties were studied.

Positive results are also obtained in composites based on polyethylene processing. Thus, the tensile strength of composite samples based on individual natural minerals increases to 18.8 MPa. In Table 3, polypropylene was used as the polymer matrix. The results are high in composites based on isotactic polypropylene, depending on its stereoregular structure. Thus, the tensile strength of composites based on volcanic ash and polypropylene reached a maximum value of 38 MPa.

Isotactic polypropylene:
$nCH_2 = CH(CH_3) \rightarrow [-CH_2-CH(CH_3)-]n$
Density, 0.90–0.91 g/cm^3
Tensile strength, 250–400 kgf/cm
Elongation, 200–800%
Flexural modulus, 6700–11,900 kgf/cm
Yield strength, 250–350 kgf/cm
Yield strength, 10–20%
Brinel hardness, 6.0–6.5 kgf/mm^2
Melting temperature, 160–170 °C
Heat resistance, 160 °C
Specific heat capacity (20–70 °C), 0.46 cal/(g·°C)
Coefficient of thermal linear expansion (20–100 °C), 1/°C 1.1·10^{-4}
Brittleness temperature, 5–15 °C
Specific volume electrical resistivity, 1016–1017 Ohm·cm
Dielectric permeability at 106 Hs 2.2
Dielectric loss tangent angle at 106 Hs 2·10^{-4}–5·10^{-5}
Electric strength (sample thickness 1 mm), 30–40 kV/mm

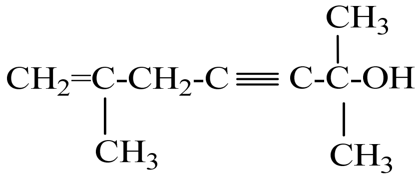
When considering the properties of isotactic polypropylene, the intramolecular arrangement rules, the characteristic properties of the additional and connecting links make it necessary to use it.

After discussing the experimental basis, we conclude that the best result is in the polyethylene and vesuvian-based composite sample. The composition of the natural mineral rock Vesuvian includes various cations and anions includes compounds containing. Vesuvian crystal is in the form of elongated columnar, prismatic and pyramidal shapes, as well as adjacent cubes. This mineral rock belongs to the copper ore deposit series. When the mineral rock, which is rich in Al and Ca elements, is included as a filler in a complex homogeneous closed composite system, the resulting material shows positive results.

LDPE/Ves./App.—30/70/2.25 sample has a strength of 18.3 MPa.

The sample with the Vesuvian-containing composite PE/Vez./App.-20/80/3% gives exceptional results, increasing the tensile strength to 34.7 MPa.

LDPE-albite-modifier 30/70/2.25 %—high result—15.0 MPa strength;
LDPE—vesuvian—appret 20/80 %—high result—34.7 MPa strength
2,6-dimethylhepten-6, 3-yn-2-ol—2.25 %—Filler-70%—good result
2,6-dimethylhepten-6, 3-yn-2-ol—3 %—Filler-80%—excellent result
$[CH_2\text{-}CH_2]_n + Ca_{19}MgFe_2Al_{10}(Si_{18}O_{70})(OH)_8$ və $(MgAl)_6(SiAl)_4O_{10}(OH)_8$



According to the Tables 7 and 8, it was determined that the strength of the sample corresponding to the proportion of volcanic ash-30 and a matrix of 70 wt.% is σ = 38 MPa, taking the maximum value. At this time, polypropylene participates in the system as a matrix. The achievement of such a result is explained by the high degree of crystallinity of polypropylene in addition to the characteristics of the filler.

Table 7. Filler—vesuvian (53-mkm).

№	Particle Size, mkm	50	53	106
1.	Filler content, %	30	40	50
2.	Tensile strength, σ, MPa	17.5	13.8	11.2
3.	Modulus of elasticity, η eff* 10^{-2}	10.2	13.2	14.5
4.	Crystallization rate, %	45	46	49
5.	Relative elongation, ε, %	30	20	25

Table 8. Filler—vesuvian (53 mkm). Apprete—2,6-dimethylhepten-6, 3-yn-2-ol (3%).

№	Composition of the Composite, %	Tensile Strength, σ, MPa	Relative Elongation, ε, %	MFİ, g/10min.
1.	LDPE-70 Filler-30 Apprete-3	7.6	19	2.1
2.	LDPE-60 Filler-40 Apprete-3	9.8	12	0.8
3.	LDPE-50 Filler-50 Apprete-3	15.0	6	0.5
4.	LDPE-40 Filler-60 Apprete-2.25	14.4	8	0.3
5.	LDPE-30 Filler-70 Apprete-2.25	18.3	4	0.3
6.	LDPE-20 Filler-80 Apprete-3	34.7	4	

Polypropylene differs from other polyolefins by a higher degree of crystallinity and a more suitable stereoregular structure. Among the composites obtained using recycled polyethylene as a matrix, the best physical and mechanical properties are possessed by the composite obtained based on Tavus clay as a filler and polymethacrylate as a primer. At this time, the tensile strength is 18.8 MPa. When considering other indicators, it is observed that the tensile strength of the composite sample based on polyethylene taken as a filler in the ratio of 80 mass% and 20 mass% vesuvianite is higher σ = 37.4 MPa.

In addition, with a number of fillers, for example: "Mining waste", "Gisil Zod", "Demirchi Dam", "Tovuz clay", "Tursh Su" the result (tensile strength) receives higher marks.

The highest result obtained with each filler is accepted. It was found that the tensile strength value is the highest for the composite sample corresponding to the ratio PE/Volcanic ash-70/30 wt.% (38 MPa).

3. Conclusions

Scientific research carried out to create polymer composite materials with complex operational properties by taking polyolefin as a polymer matrix, natural mineral rocks of various nature, composition and dispersion as a filler, and a dressing with appropriate functionality as a dressing, always maintains its relevance. We, as researchers, have also carried out scientific research work in this direction and achieved positive results. Thus, considering several superior properties, low-density polyethylene-based composite samples were processed and the physical and mechanical indicators of the created products were studied. It was determined that composites with superior strength properties are those corresponding to the matrix-filler-dressing system. In terms of taking into account a number of properties, the properties of the system in which the natural mineral rock Vesuvian corresponds to 80% by mass were obtained more satisfactory.

The positive trend of the results is actually characterized by the location, relief and landscape richness, nature and shape of the natural mineral rock taken. Thus, when Vesuvian natural mineral rock is included in the composite as a filler, the results are good, and the value of the tensile strength limit reaches a maximum. The richness of the mineralogical and chemical composition of Vesuvian, and the landscape richness of the area from which it was taken are clear evidence of this. Conducting experiments considering all these criteria creates the basis for obtaining positive results.

These type of materials can be applied in various fields. Thus, it has been proven that they are products suitable for exploitation. Such products can be widely used in the production of construction products.

Author Contributions

Coceptualization—J.V.J. and A.N.A. Methodology—J.V.J.; Software—N.D.R.; Validation—J.V.J., A.N.A., R.M.J.; Formal Analysis B.S.A.; Investigation—A.N.A.; Resources—M.G.H.; Data Curation—K.S.M. and R.M.J.; Writing—Original Draft Preparation—A.N.A.; Visualization—J.V.J.; Supervisio—J.V.J.

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All relevant data are within the paper.

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