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STUDY OF PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES OF ACRYLIC TERPOLYMER

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Abstract. In this study, the structure and properties of a terpolymer based on methyl methacrylate (MMA), 2-ethylhexyl acrylate (2-EHA), and methacrylic acid (MAA) were investigated. The chemical structure of the resulting material was determined using infrared spectroscopy (IR). IR spectroscopy results showed that the terpolymer contains carbonyl (C=O), ester (C–O–C), and methyl and methylene groups ($–CH_3$, $–CH_2$), confirming the formation of a terpolymer based on MMA, 2-EHA, and MAA monomers. Furthermore, the surface morphology of the material was studied using scanning electron microscopy (SEM). SEM micrographs revealed that the terpolymer structure consists of layered aggregates, micropores, and particles of varying sizes. This morphological structure can influence the physical and mechanical properties of the polymer. The mechanical properties of the obtained copolymer samples were also studied, including their tensile strength, elongation, and viscosity. The results revealed that the mechanical properties of the samples depend on their compositional characteristics. The studies comprehensively characterized the structure and properties of the MMA-2-EHA-MAA-based terpolymer, demonstrating its practical application. Furthermore, the mechanical properties of the terpolymer samples were studied, including their tensile strength, elongation, and viscosity. The results revealed that the tensile strength of the samples ranged from 18.6 to 31.88 MPa, elongation from 20 to 60%, and viscosity from 610 to 1100 Hz. The study demonstrated that the structural characteristics of the polymer significantly influence its mechanical properties. The studies confirmed the chemical structure and morphological properties of the MMA-2-EHA-MAK-based terpolymer, and the mechanical properties of the resulting materials demonstrated their practical application.

Keywords: methyl methacrylate (MMA); ethylhexyl acrylate (EHA); methacrylic acid (MAA); scanning electron microscope (SEM); infrared spectroscopy (IR)

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АКРИЛ ТЕРПОЛИМЕРДІҢ ФИЗИКА-ХИМИЯЛЫҚ ЖӘНЕ МЕХАНИКАЛЫҚ ҚАСИЕТТЕРІН ЗЕРТТЕУ

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Аннотация: Бұл жұмыста метилметакрилат (ММА), 2-этилгексилакрилат (2-ЭГА) және метакрил қышқылы (МАҚ) негізінде алынған терполимердің құрылымы мен қасиеттері зерттелді. Зерттеу барысында алынған материалдың химиялық құрылымы инфрақызыл спектроскопия (ИҚ) әдісі арқылы анықталды. ИҚ-спектр нәтижелері сополимер құрамында карбонил (C=O), эфирлік (C–O–C), сондай-ақ метил және метилен топтарының ($–CH_3$, $–CH_2$) бар екенін көрсетті, бұл ММА, 2-ЭГА және МАҚ мономерлері негізінде терполимердің түзілуін дәлелдейді. Сонымен қатар материалдың беткі морфологиясы сканерлеуші электрондық микроскопия (СЭМ) әдісі арқылы зерттелді. СЭМ микросуреттері сополимердің құрылымы қабатталған агрегаттардан, микрокеуектерден және әртүрлі өлшемдегі бөлшектерден тұратынын көрсетті. Мұндай морфологиялық құрылым полимердің физика-механикалық қасиеттеріне әсер етуі мүмкін. Алынған терполимер үлгілерінің механикалық қасиеттері де зерттеліп, олардың созылу беріктігі, салыстырмалы ұзаруы және тұтқырлығы анықталды. Оның нәтижелері бойынша үлгілердің механикалық көрсеткіштері олардың құрамдық ерекшеліктеріне тәуелді екені анықталды. Жүргізілген зерттеулер нәтижесінде ММА-2-ЭГА-МАҚ негізіндегі терполимердің құрылымы мен қасиеттері кешенді түрде сипатталып, оның практикалық қолдану мүмкіндігі көрсетілді. Сонымен қатар терполимер үлгілерінің механикалық қасиеттері зерттеліп, олардың созылу беріктігі, салыстырмалы ұзаруы және тұтқырлығы анықталды. Алынған нәтижелер бойынша үлгілердің созылу беріктігі 18,6 – 31,88 МПа, салыстырмалы ұзаруы 20 – 60 %, ал тұтқырлығы 610 –1100 Гц аралығында өзгеретіні анықталды. Зерттеу нәтижелері полимердің құрылымдық ерекшеліктері оның механикалық қасиеттеріне айтарлықтай әсер ететінін көрсетті. Жүргізілген зерттеулер ММА-2-ЭГА-МАҚ негізіндегі терполимердің химиялық құрылымы мен морфологиялық ерекшеліктерін растады және алынған материалдардың механикалық қасиеттері олардың практикалық қолдану мүмкіндігін көрсететінін дәлелдеді.

Түйін сөздер: метилметакрилат (ММА), этилгексил акрилат (ЭГА), метакрил қышқылы (МАҚ), сканерлеуші электрондық микроскоп (СЭМ), инфрақызыл спектроскопия (ИҚ).

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ИЗУЧЕНИЕ ФИЗИКО-ХИМИЧЕСКИХ И МЕХАНИЧЕСКИХ СВОЙСТВ АКРИЛОВОГО ТЕРПОЛИМЕРА

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Аннотация: В данной работе исследованы структура и свойства терполимера на основе метилметакрилата (ММА), 2-этилгексилакрилата (2-ЭГА) и метакриловой кислоты (МАК). В ходе исследования химическая структура полученного материала определялась методом инфракрасной спектроскопии (ИК). Результаты ИК-спектроскопии показали, что сополимер содержит карбонильные (C=O), эфирные (C–O–C), а также метильные и метиленовые группы ($–CH_3$, $–CH_2$), что подтверждает образование терполимера на основе мономеров ММА, 2-ЭГА и МАК. Морфология поверхности материала была изучена методом сканирующей электронной микроскопии (СЭМ). Микрофотографии СЭМ показали, что структура терполимера представлена слоистыми агрегатами, микропорами и частицами различного размера, что может оказывать влияние на физико-механические свойства материала. Были также исследованы механические свойства полученных образцов терполимера, включая прочность на разрыв, относительное удлинение и вязкость. Установлено, что механические показатели зависят от композиционных особенностей материала. Прочность на разрыв варьируется от 18,6 до 31,88 МПа, относительное удлинение - от 20 до 60%, а вязкость - от 610 до 1100 Гц. Результаты исследования показали, что структурные особенности полимера существенно влияют на его механические свойства. Проведённые исследования подтвердили химическую структуру и морфологические характеристики терполимера на основе ММА–2-ЭГА–МАК, а также продемонстрировали перспективность его практического применения.

Ключевые слова: метилметакрилат (ММА); этилгексилакрилат (ЭГА); метакриловая кислота (МАК); сканирующий электронный микроскоп (СЭМ); инфракрасная спектроскопия (ИК)

Introduction. This class of acrylic terpolymers is widely used in the production of paints and varnishes due to the ability of the ethylhexyl acrylate component to provide film elasticity, while methyl methacrylate is responsible for the hardness and resistance of the coating to external influences (Singh, 2017). The introduction of fragments with a low glass transition temperature into the copolymer structure allows for the adjustment of the adhesion characteristics of the material, making it a promising binder for the creation of highly effective pressure-sensitive adhesives (Körpınar et al., 2022). The combination of these monomers also helps improve the film-forming properties and operational durability of coatings in various climatic conditions (Boudraa et al., 2020).

Modification of these systems with functional additives allows for further variation of viscosity and crosslinking density, which is critical in the development of specialized protective compounds with specified physical and mechanical properties (Mozelewska et al., 2021). Optimization of the molecular weight distribution and ratio of acrylic components ensures the formation of stable polymer matrices capable of maintaining their strength properties when exposed to organic solvents and variable temperatures. Furthermore, the use of ethylhexyl acrylate in the copolymer significantly reduces the brittleness of the final product, preventing cracking under intense mechanical stress. Current research focuses on the influence of various radical polymerization mechanisms on the topology of molecular chains and the formation of graft copolymers. Particular attention is paid to methods for controlling the hydrophilic-hydrophobic balance of macrochains, which opens up broad possibilities for the targeted synthesis of polymers with specified physicomechanical parameters (Dauitbayeva et al., 2021). Also of significant interest is the integration of organofunctional silanes into polymer matrices, which can significantly improve the adhesion properties of composites when in contact with glass and silicon-containing substrates (Andre, 2022).

Literary review. Methyl methacrylate and ethylhexyl acrylate are key monomers in the modern organic synthesis industry, forming the basis for a wide range of polymeric materials with high transparency, mechanical strength, and thermal stability (Lapychak et al., 2016). While methyl methacrylate is traditionally used in the production of polymethyl methacrylate, ethylhexyl acrylate is widely used as a base component of adhesives and elastomers, providing the necessary performance characteristics to the final products (Yevlampieva et al., 2016). Due to its low glass transition temperature, ethylhexyl acrylate is effectively used as a soft segment in thermoplastic elastomers, imparting the required flexibility and durability to polymer matrices (Boudraa et al., 2020). The combination of these monomers during copolymerization allows for fine-tuning the physicochemical properties of the composites, expanding their application range from high-strength engineering plastics to specialized adhesive systems (Lapichak et al., 2016). In particular, the use of copolymers based on these components enables the creation of highly effective adhesives for the electrical industry and the production of protective marking materials. Studies of the thermodynamic parameters of the interaction of such monomers with solvents play a critical role in optimizing their polymerization processes, ensuring control over the molecular weight distribution and purity of the final product (Serheyev, 2012). This paper examines the influence of the chemical structure of these monomers on the enthalpy of mixing and the nature of intermolecular interactions in solutions, which allows for a deeper understanding of the mechanisms underlying the formation of polymer film properties (Serheyev, 2015). Particular attention is paid to analyzing the influence of side-chain substituent polarity on the kinetic characteristics of radical polymerization in various reaction environments (Ezhilan and Varadhan, 2024). Comparative analysis of these systems allows us to identify patterns in the influence of steric factors on the stability of active chain growth sites. Experimental results confirm that the introduction of ethylhexyl acrylate units into the methacrylate chain significantly reduces internal stresses in cured coatings, increasing their resistance to atmospheric exposure (Singh, 2017).

Methods and materials.

Synthesis of a terpolymer based on methyl methacrylate, 2-ethylhexyl acrylate and methacrylic acid. The terpolymer based on MMA, 2-EHA and MAA monomers was synthesized by the bulk polymerization method, by the radical polymerization mechanism, in the presence of 2,2-azo-bis-isobutyronitrile (AIBN) initiator. The initial monomer mixtures in the terpolymer composition were taken in the following volume ratios: MMA-2-EHA-MAA = M1 (65-30-5), M2 (75-20-5) and M3 (80-15-5) wt.%.

A portion (10 ml) of all monomers (MMA-2-EHA-MAA) was poured into a round-bottomed three-necked flask, then heated in a water bath at 60°C. When the water bath reached a certain temperature, nitrogen or argon gas was introduced into the reaction mass. The remaining volume of the MMA-2-EGA-MAK mixture was treated with the initiator AIBN (0.1 g) and added dropwise for 4 hours at 65°C (approximately 12 ml/h), and then synthesized at 80°C for 1 hour.

The resulting MMA-2-EHA-MAA terpolymer was dissolved in acetone, reprecipitated first in methanol, then in diethyl ether several times, and dried in a vacuum oven.

The main reaction for the synthesis of the MMA-2-EHA-MAA-based terpolymer was demonstrated by conducting studies using physicochemical and physicomechanical research methods in order to characterize the various properties of the copolymers obtained with the following reaction mechanism.

Films based on terpolymer powder. To prepare these films, powders of the synthesized MMA-2-EHA-MAK terpolymer in different ratios were dissolved in methyl methacrylate (MMA) monomer at room temperature (25°C), and benzoyl oxide was used as an initiator (BT content 0.1% by volume of copolymer and terpolymer). When MMA monomer is added to the terpolymer chains, the polymer gradually melts, turns into a viscous state, and its viscosity increases after a few minutes.

The films were obtained by pouring the resulting mixture into a special flat container and drying at room temperature. The physicomechanical properties of the obtained films were studied.

Results.

FTIR Analysis.

To determine the structure of the terpolymer based on MMA, 2-EHA, and MAA, their IR spectra were recorded and studied (Fig. 1). The appearance of absorption bands corresponding to the functional groups of the original monomer components is observed.

To confirm the chemical structure of the MMA-2-EHA-MAA-based copolymer, infrared (IR) spectroscopic analysis was performed. The IR spectrum allows one to determine the presence of polymer functional groups and their interactions within the molecular structure. The spectrum shown in the figure displays several characteristic absorption bands corresponding to the main functional groups of the copolymer.

A stretching vibration region characteristic of the MMA monomer was recorded in the synthesized terpolymer; a broad absorption band at 3441 cm^{-1} corresponds to vibrations of the hydroxyl group (–OH). This signal indicates the presence of carboxyl groups in methacrylic acid (MAA) or hydrogen bonds between polymer chains.

Absorption bands at 2960 and 2875 cm⁻¹ correspond to symmetric and asymmetric stretching vibrations of alkyl groups (–CH_3 and –CH_2). These signals confirm the presence of hydrocarbon chains of methyl methacrylate (MMA) and 2-ethylhexyl acrylate (2-EHA) fragments.

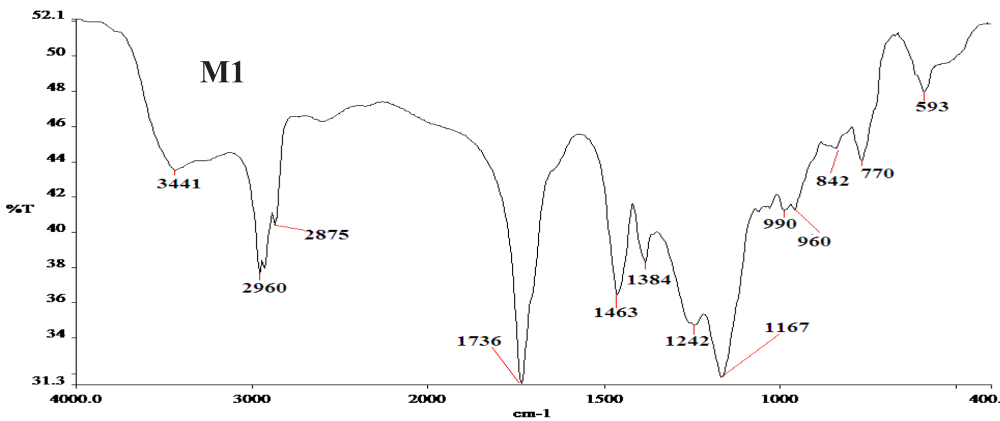
A prominent absorption band at 1736 cm^{-1} is characteristic of the stretching vibrations of the carbonyl group (C=O). This signal is one of the main functional groups characteristic of acrylate and methacrylate esters and indicates the presence of ester groups in the terpolymer.

The absorption bands at 1463 and 1384 cm^{-1} correspond to the deformation vibrations of the methyl and methylene groups. These signals confirm the presence of hydrocarbon structures in the polymer chain.

The absorption bands observed at 1242 and 1167 cm^{-1} correspond to the stretching vibrations of the ester bonds (C–O–C). These bands are characteristic of the structure of acrylate and methacrylate esters.

Furthermore, the signals in the 990 and 960 cm^{-1} regions correspond to vibrations of vinyl fragments or hydrocarbon backbones in the polymer chain. Meanwhile, the absorption bands in the 842 and 770 cm^{-1} regions are characteristic of out-of-plane deformation vibrations of hydrocarbon groups. The weak signal in the 593 cm^{-1} region may be associated with vibrations of the main chain in the molecular structure.

More specifically, the O–H group is observed in the range of 3441–3414 cm^{-1}. Stretching vibrations are found in the range of 1734–1736 cm^{-1} for the C=O bond, and stretching vibrations are characteristic of acidic carbonyl and ester groups, while the C–O–C bond is located in the range from 1242 to 1167 cm^{-1}. Deformation vibrations were recorded in the range of 1466–1384 cm^{-1} for the CH_2 group, while an intense peak of the CH_3 group was recorded in the region of 2960–2919 cm^{-1}, and for the CH group, in the range from 2875 to 2851 cm^{-1} (Smith, 2023).



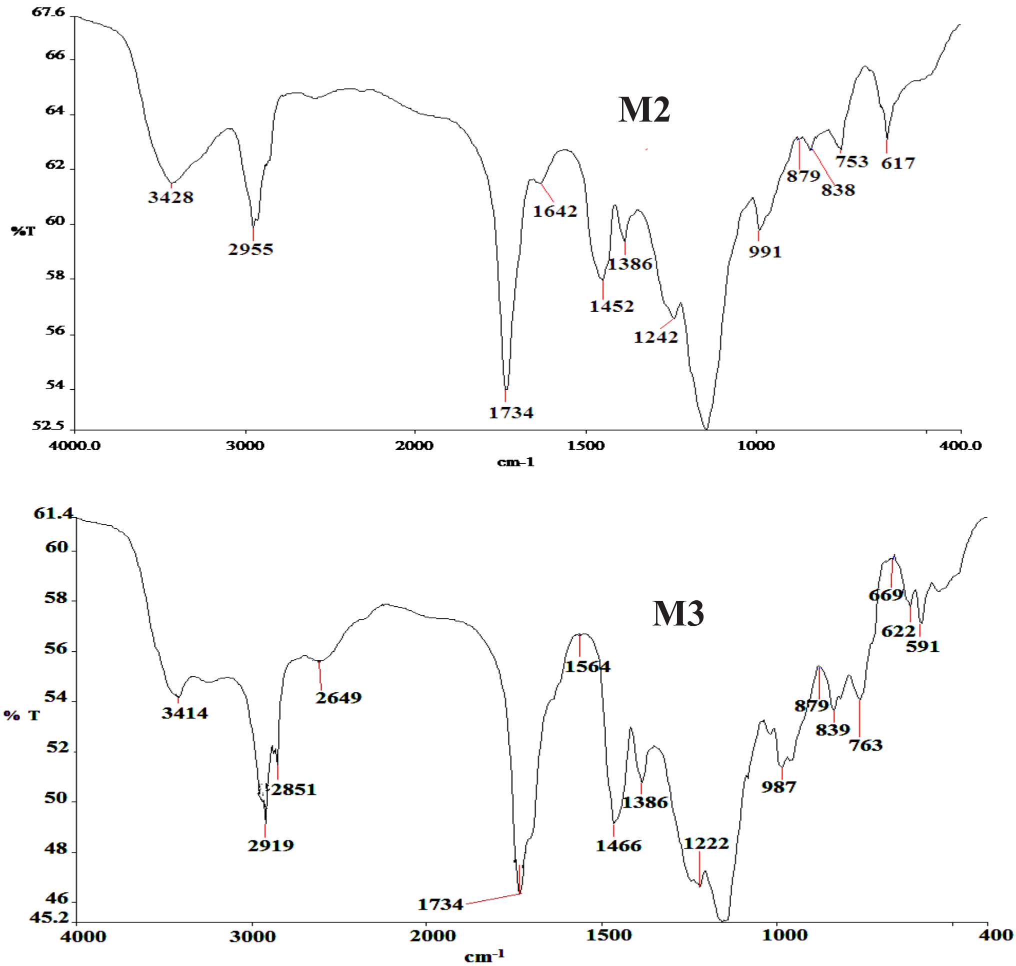


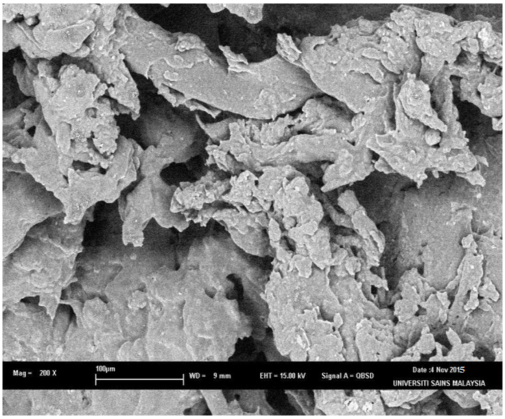
Figure 1 — IR spectrum of MMA-2-EHA-MAA-based terpolymer, M1 (65-30-5), M2 (75-20-5) and M3 (80-15-5) wt.%

SEM Analysis. The scanning electron microscope (SEM) method was used to study the morphology of the terpolymer structure. SEM micrographs of the terpolymer are presented in Figure 2. From the SEM analysis of the samples formed from the terpolymer, it is observed that they differ somewhat in practice depending on the amount of monomer. The nature of the monomer and the percentage of the initial monomers in the mixture affect the morphology of the polymer particles. In this regard, as shown in Figure 2, it was observed that the surface folds were observed with a decrease in the MMA concentration, and with a decrease in the concentration of 2-EHA, folds were formed due to the longer side chains, and as the concentration of MMA monomers increased, the total number of pore-like spheres increased. It was found that the surface layer of the terpolymer (M3) based on MMA and 2-EHA was thinner.

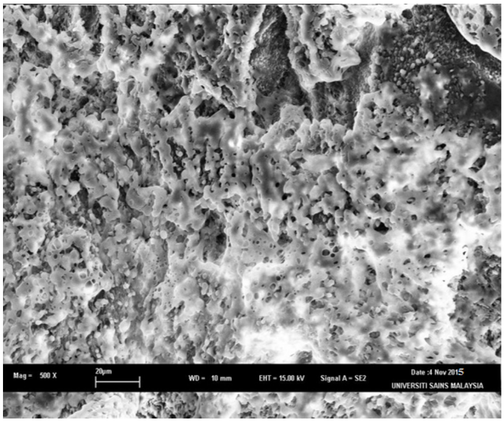
The obtained micrographs revealed that the copolymer surface structure is uneven and has a complex morphology. The first micrograph shows that the sample structure consists of layered and lamellar aggregates. The polymer particles are tightly interconnected, forming large aggregates. This structure is formed by the interaction of polymer chains. Furthermore, the presence of small cracks and cavities in the surface layer indicates a certain degree of porosity in the internal structure of the material.

The second micrograph shows a porous structure on the sample surface, consisting of numerous micropores and small particles. This structure indicates that the micropores form within the polymer matrix, and the particles are unevenly distributed. This porous morphology can increase the surface area of the material and affect its physicochemical properties.

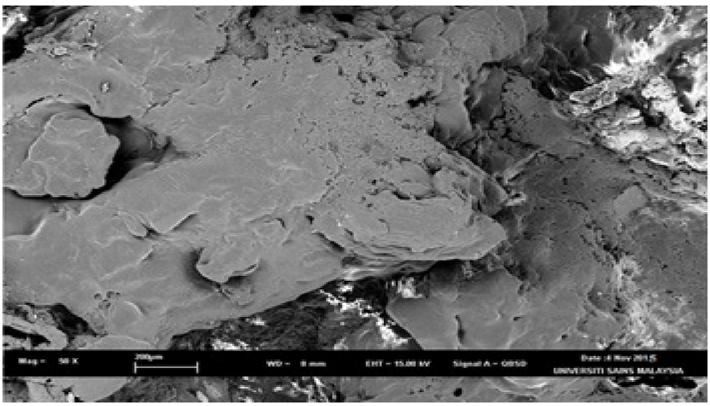
The third micrograph shows a relatively dense and smooth structure. In this region, the polymer layers are well interconnected, and the aggregates form large lamellar structures. This morphology indicates high structural strength of the polymer (Bikiaris, 2013).



M1



M2



M3

Figure 2 — SEM micrographs of MMA-2-EHA-MAA-based terpolymers, M1 (65-30-5), M2 (75-20-5) and M3 (80-15-5) wt.%

Determining the Viscosity of Powder Films. One of the important rheological characteristics of polymer systems is their viscosity. Viscosity characterizes the internal resistance of polymer solutions or dispersions to flow and depends on the length of polymer chains, intermolecular interactions, and structural features of the system. The viscosity index is an important parameter in assessing the processability of a material, its film-forming ability, and its applicability. Viscosity is one of the most important characteristics of acrylic polymers [190-191]. The viscosity of the acrylic polymer was determined using a Brookfield viscometer. Standard method ASTM D4878 was used to determine the viscosity of acrylic compounds. The viscosity of the MMA-2-EGA-MAK copolymer was measured at 25°C and is shown in Figure 3.

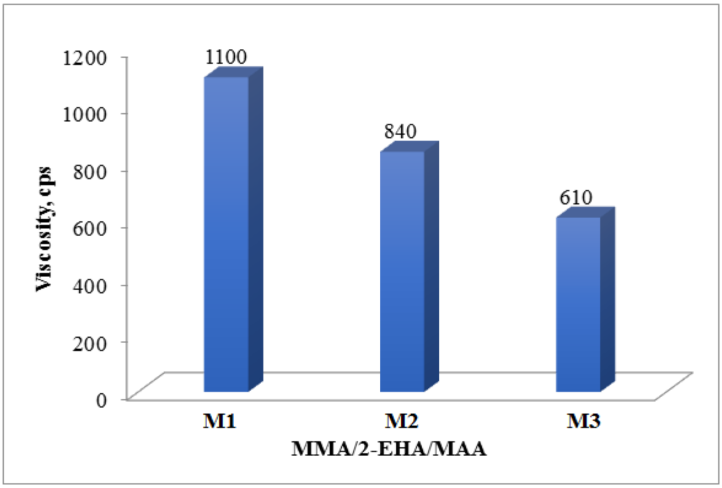


Figure 3 — Viscosity of Terpolymer Films in Different Ratios

The study determined the viscosity of MMA-2-EHA-MAA-based powder films. The results revealed differences in viscosity between the samples. As shown in the diagram, the viscosity of sample M1 was 1100 Hz, sample M2 was 840 Hz, and sample M3 was 610 Hz.

A comparative analysis of the results revealed a gradual decrease in viscosity between the samples. The highest viscosity was recorded for sample M1. This indicates strong interactions between macromolecules in the polymer system and tight bonding between molecular chains. This structure increases the internal resistance of the solution to flow, resulting in high viscosity.

The decrease in viscosity in samples M2 and M3 can be explained by increased polymer chain mobility or weakening of intermolecular bonds in the system. In particular, the lowest value (610 Hz) in sample M9 indicates that the polymer structure is relatively more flexible, and the system's flow resistance is reduced.

Thus, the obtained results demonstrate that the viscosity properties of MMA-2-EHA-MAA-based powder films depend on their composition and structural features. Changes in the viscosity index allow one to evaluate the rheological properties of the polymer system and play an important role in determining the technological processing of materials, as well as their practical application. It was found that the methyl group in the terpolymer, i.e., the carboxylic acid, is dependent on changes in temperature and polymer concentration, and the viscosity of acrylic compounds can be controlled using these data (Deka, et al., 2020).

Determining the Tensile Strength of Powder Films. One important parameter when assessing the mechanical properties of powder films is their tensile strength. This parameter characterizes the load a material can withstand before failure under external forces. Tensile strength depends on the structural properties of the polymer materials, the interaction of macromolecules, and the density of the polymer network. The mechanical properties of MMA-2-EHA-MAA terpolymer films with different ratios are shown in Figure 4.

The study determined the tensile strength of MMA-2-EHA-MAA-based powder films. The results showed that the tensile strength of sample M1 was 18.6 MPa, sample M2 was 26.8 MPa, and sample M3 was 31.88 MPa. As the diagram shows, a gradual increase in tensile strength was observed between the samples.

The highest value was recorded for sample M3, indicating the high mechanical strength of this material. This phenomenon can be explained by increased interaction between polymer chains, increased network density, or the strength of intermolecular bonds. The relatively low value for sample M1 indicates a more flexible polymer structure and lower network density.

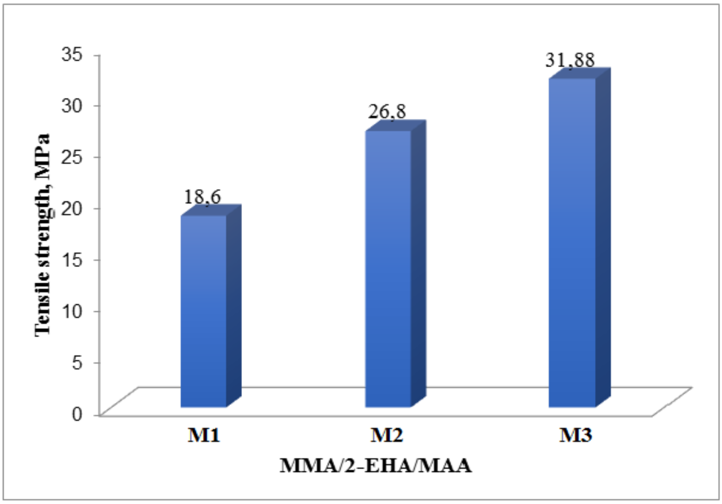


Figure 4 —Tensile Strength of terpolymer Films with Different Ratios

Thus, the study results demonstrated that the tensile strength of MMA-2-EHA-MAA-based powder films depends on their compositional properties. This indicator is important in assessing the mechanical stability of materials and determining their practical applicability.

According to the data obtained, the very high tensile strength is due to the presence of carboxyl groups in the MAA monomer in the terpolymer, which act as an additional crosslinking agent during film curing. The internal ionic center of the MAA monomer contributes positively to the polymer's properties, forming hydrogen bonds and significantly increasing the mechanical strength of the materials. Furthermore, the hard MMA segment is known to be present as a physically pure substance, which is typically associated with the strength properties of acrylic polymer (Boudraa, et al., 2020).

Determining the Relative Elongation of Films. One of the important parameters characterizing the mechanical properties of powder films is their relative elongation at break. This parameter characterizes the degree of elasticity of the material, its tensile strength, and the freedom of movement of the polymer chains. The higher the relative elongation, the greater the flexibility and plasticity of the material. In this terpolymer, the relative elongation at break decreases, as shown in Figure 5.

The study determined the elongation of MMA-2-EHA-MAA-based films. The results showed that the elongation of sample M1 was 60%, the highest among the samples studied. For sample M2, this value was 45%, and for sample M3, it was 20%.

The results of this study demonstrate that the compositional characteristics of the films significantly influence their mechanical properties. The high elongation of sample M1 indicates the high flexibility of the polymer chains and their ability to move together. Meanwhile, the decreased elongation values in samples M2 and M3 may be due to increased rigidity of the polymer structure or the density of the network structure.

Thus, the studies demonstrated that the mechanical properties of MMA-2-EHA-MAA-based powder films depend on their composition and structural characteristics. The relative elongation index is an important parameter in assessing the elastic properties of materials and allows determining their practical applicability (Mark, J. E. 2007).

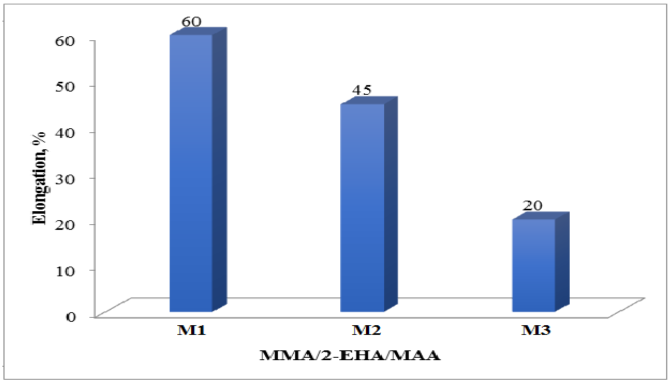


Figure 5 — Elongation of Terpolymer Films in Various Ratios

Discussion. When assessing the performance of polymeric materials, their mechanical and rheological properties play an important role. In this regard, the mechanical properties of powder films based on MMA-2-EHA-MAA, including tensile strength and elongation at break, as well as rheological properties (viscosity), were studied. These parameters characterize the structural properties of polymeric materials, intermolecular interactions, and their resistance to external influences. The study found that the mechanical properties of films based on MMA-2-EHA-MAA vary depending on the compositional characteristics of the samples. According to the data obtained, the tensile strength of sample M1 was 18.6 MPa, sample M2 – 26.8 MPa, and sample M3 – 31.88 MPa. These results indicate a gradual increase in tensile strength between samples. The highest mechanical strength was observed for sample M3. This phenomenon can be explained by the strengthening of bonds between macromolecules in the polymer system, as well as an increase in the density of the structural network. Strengthening the interaction of polymer chains increases the material's resistance to external mechanical loads.

The relative elongation at break showed an inverse trend between the samples. According to the study results, the relative elongation in sample M1 was 60%, in sample M8 it was 45%, and in sample M3 it was 20%. The highest relative elongation was observed in sample M1, indicating the high elasticity of this material. This property may be related to the free movement of the polymer chains and the relatively weak bonds between them. The low relative elongation in sample M3 is explained by the increased rigidity of the material's structure and the dense arrangement of the polymer network. This situation demonstrates a pattern often observed in polymeric materials: as tensile strength increases, relative elongation decreases.

Furthermore, the study determined the viscosity of powder films based on MMA-2-EHA-MAA. According to the obtained results, the viscosity of sample M1 was 1100 Hz, sample M2 was 840 Hz, and sample M3 was 610 Hz. The gradual decrease in viscosity values may be due to increased macromolecular mobility in the polymer system or weakening of intermolecular bonds. The highest viscosity was recorded for sample M1, indicating a high level of interaction between the polymer chains and a high level of internal resistance in the system.

Conclusion.

The conducted studies allowed for a comprehensive evaluation of the structural, morphological, and mechanical properties of the MMA-2-EHA-MAA-based terpolymer. IR spectroscopy results confirmed the chemical structure of the copolymer formed from MMA, 2-EHA, and MAA monomers. Absorption bands characteristic of carbonyl, ester, and hydrocarbon groups observed in the spectrum indicate the presence of acrylate and methacrylate moieties in the synthesized polymer. This demonstrates the successful formation of the chemical structure of the MMA-2-EHA-MAA terpolymer.

Scanning electron microscopy (SEM) results revealed that the surface morphology of the terpolymer consists of a layered structure, micropores, and aggregated particles. This morphological structure contributes to an increase in the surface area of the material and can influence its physicochemical properties, adhesion, and mechanical stability. Furthermore, the observed microporous structure can improve the functional properties of the material. The results of mechanical and rheological studies showed that the properties of MMA-2-EHA-MAA-based powder coatings are directly dependent on their structural features. While sample M1 exhibits high elasticity and viscosity, sample

M3 is characterized by high mechanical strength. These differences are explained by the relative positions and bonding characteristics of the macromolecules in the polymer system.

Thus, the obtained results demonstrate a relationship between the structure and properties of MMA-2-EHA-MAA-based powder coatings. The properties of polymeric materials can be specifically controlled by varying their composition and synthesis conditions. The conducted studies allowed for a comprehensive assessment of the physical and mechanical properties of the obtained materials and served as a basis for determining their potential for practical application.

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