EURASIAN JOURNAL OF ACADEMIC RESEARCH
Innovative Academy Research Support Center
UIF = 8.1 | SJIF = 5.685 www.in-academy.uz

PHYSICAL AND CHEMICAL PROPERTIES OF POLYMER HYBRID MATERIALS

Aytmuratova Altinay Yelmuratovna
Intern-teacher of the Department of Physical and Colloidal Chemistry, Karakalpak State University
https://www.doi.org/10.5281/zenodo.8098711

ARTICLE INFO

Received: 23th June 2023
Accepted: 29th June 2023
Online: 30th June 2023

KEY WORDS

Chemistry, materials, physical and chemical properties, polymer, application.

ABSTRACT

Polymer hybrid materials are a combination of two or more different types of materials, typically polymers and inorganic materials. These hybrid materials exhibit unique physical and chemical properties that are different from those of their individual components. Some of the physical and chemical properties of polymer hybrid materials include improved mechanical properties such as higher strength, toughness, and stiffness compared to pure polymers, improved thermal stability, electrical conductivity, unique optical properties such as transparency, color, and luminescence, improved chemical resistance, biocompatibility, and the ability to exhibit either hydrophilic or hydrophobic properties depending on the nature of the inorganic component used. This article explores polymer hybrid materials to offer a wide range of physical and chemical properties that can be tailored for specific applications.

Polymer hybrid materials are a combination of two or more different types of materials, typically polymers and inorganic materials. These hybrid materials exhibit unique physical and chemical properties that are different from those of their individual components [6, 50-52]. Some of the physical and chemical properties of polymer hybrid materials are:

1. Mechanical properties: Polymer hybrid materials have improved mechanical properties such as higher strength, toughness, and stiffness compared to pure polymers. This is due to the reinforcement effect of the inorganic component.

2. Thermal stability: Polymer hybrid materials show improved thermal stability due to the presence of inorganic components, which can withstand high temperatures.

3. Electrical conductivity: Polymer hybrid materials can exhibit electrical conductivity due to the presence of conductive inorganic materials [3].

4. Optical properties: Polymer hybrid materials can exhibit unique optical properties such as transparency, color, and luminescence due to the presence of inorganic components.

5. Chemical resistance: Polymer hybrid materials can exhibit improved chemical resistance due to the presence of inorganic components, which can resist chemical attacks.

6. Biocompatibility: Polymer hybrid materials can be designed to be biocompatible, making them suitable for biomedical applications.

7. Hydrophilicity/hydrophobicity: Polymer hybrid materials can exhibit either hydrophilic or hydrophobic properties depending on the nature of the inorganic component used [1].

As can be seen, polymer hybrid materials offer a wide range of physical and chemical properties that can be tailored for specific applications.

Polymer hybrid materials are a relatively new class of materials that have gained significant attention in recent years due to their unique physical and chemical properties. One of the most significant advantages of polymer hybrid materials is their improved mechanical properties. By combining the strength and stiffness of inorganic materials with the flexibility and ductility of polymers, these materials can exhibit higher strength, toughness, and stiffness compared to pure polymers. This makes them ideal for applications where high mechanical performance is required, such as in structural materials, composites, and coatings [4].

In addition to improved mechanical properties, polymer hybrid materials can also exhibit unique optical properties. By incorporating inorganic materials with specific optical properties, such as luminescence or color, these materials can be tailored for specific applications such as sensors, displays, and lighting.

Another advantage of polymer hybrid materials is their improved thermal stability. Inorganic materials are typically more heat-resistant than polymers, and by combining the two, the resulting material can exhibit improved thermal stability, making it suitable for high-temperature applications.

Chemically, polymer hybrid materials can also offer unique properties. For example, by incorporating biocompatible inorganic materials, these materials can be used in medical applications such as drug delivery systems, tissue engineering, and implants [2, 70-74].

However, there are some disadvantages of polymer hybrid materials which include the followings:

1. Limited mechanical properties: Polymer hybrid materials may not possess the same level of mechanical strength and durability as pure metals or ceramics. This can limit their applications in high-stress environments or where high load-bearing capacity is required.

2. Processing challenges: Polymer hybrid materials often require specialized processing techniques, such as melt blending or solution mixing, to achieve the desired combination of properties. These processes can be complex and time-consuming, leading to higher production costs.

3. Thermal stability limitations: Polymers generally have lower thermal stability compared to metals or ceramics. Incorporating polymers into hybrid materials can lower the overall thermal stability of the composite, making it unsuitable for high-temperature applications.

4. Limited chemical resistance: Polymers may not exhibit the same level of chemical resistance as pure metals or ceramics. The presence of polymers in hybrid materials can make them susceptible to degradation or chemical attack in certain environments, limiting their use in corrosive or reactive conditions.

5. Dimensional instability: Polymers can exhibit dimensional changes with temperature variations or exposure to moisture. This can lead to dimensional instability in polymer hybrid materials, affecting their overall performance and reliability.

6. Limited electrical conductivity: Polymers are generally insulators and have low electrical conductivity. Incorporating polymers into hybrid materials can limit their electrical conductivity, making them unsuitable for applications that require good electrical conductivity or shielding properties.

7. Variability in properties: The properties of polymer hybrid materials can vary depending on factors such as the type and concentration of the polymer, the processing conditions, and the quality of the interface between the polymer and the other components. This variability can make it challenging to consistently achieve the desired properties in these materials.

8. Environmental concerns: Some polymer hybrid materials may contain hazardous substances, such as certain additives or fillers, which can pose environmental risks during their production, use, or disposal. Proper handling and disposal practices are necessary to mitigate these concerns [5].

The physical and chemical properties of polymer hybrid materials are important because they determine the material's performance and suitability for various applications. For example, a material with high strength and toughness would be ideal for structural applications, while a material with unique optical properties would be useful in the development of sensors and devices.

Furthermore, the ability to tailor the chemical properties of polymer hybrid materials allows for specific interactions with other materials or environments, making them useful in a variety of fields such as medicine, catalysis, and environmental remediation.

Conclusion. Polymer hybrid materials offer a unique combination of physical and chemical properties that make them highly desirable for a wide range of applications. These materials exhibit improved mechanical properties, enhanced thermal stability, and unique optical and chemical properties. As research in this field continues to advance, it is likely that we will see an increasing number of innovative applications for these materials in the future. Overall, understanding and controlling the physical and chemical properties of polymer hybrid materials is crucial for developing new materials with enhanced properties and functionality for various applications.

References:

1. Аскадский, А. А. Физико-химия полимерных материалов и методы их исследования / А. А. Аскадский. – М.: АСВ, 2015. – 408 с.
2. Базунова М.В., Чернова В.В., Салихов Р.Б., Кулиш Е.И., & Захаров В.П. (2018). ФИЗИКО-ХИМИЧЕСКИЕ СВОЙСТВА ПОЛИМЕРНЫХ КОМПОЗИТОВ НА ОСНОВЕ ПОЛИОЛЕФИНОВ И ИХ ОТХОДОВ И ЛУЗГИ ПОДСОЛНЕЧНИКА. Вестник Башкирского университета, 23 (1), 70-74.
3. Лирова, Б. И. Анализ полимерных композиционных материалов / Б. И. Лирова, Е. В. Русинова. – Екатеринбург: Изд-во Урал. ун-та, 2008. – 187 с.

4. Лобанов, А. Н. Полимеры: физико-химические свойства, способы получения и методы идентификации / А. Н. Лобанов, И. А. Лобанова, Я. М. Станишевский. – М.: РУДН, 2016. – 78 с.
5. Новопольцева, О. М. Современные физико-химические методы исследования органических веществ и полимеров [Электронный ресурс] / О. М. Новопольцева, Б. С. Орлинсон, О. В. Бычкова. – Волгоград: ВПИ, 2012. – 100 с
6. Осипова В.В., Чаусов Д.Н., Беляев В.В., & Галяметдинов Ю.Г. (2014). Физико-химические свойства композитов на основе светоизлучающих компонентов. Вестник Казанского технологического университета, 17 (17), 50-52.