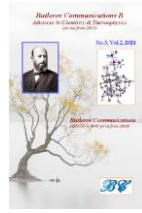
BUTLEROV HERITAGE

Butlerov Communications B
Advances in Chemistry & Thermophysics
ISSN 2074-0948 (print)

2021. Vol.2, No.3, Id.8.
Journal Homepage: https://b-journal.butlerov.com/



Thematic section: Research into New Technologies.
Subsection: Polymer and Composite Technology.

Full Paper

The Reference Object Identifier – ROI-jbc-B/21-2-3-8
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-B/21-2-3-8
Received 10 October 2021; Accepted 13 October 2021

Influence of plasma treatment of disperse fillers on the characteristics of a polyurethane matrix with their use

Tatyana V. Burdikova, **Lyubov A. Zenitova**,*[+] and **Sergey S. Ivshin**
Kazan National Research Technological University. K. Marx St., 68. Kazan, 420015. Republic of Tatarstan. Russia. Phone: +7 917 394 9767.
E-mail: Lnubov_zenitova@mail.ru

*Supervising author; [+]Corresponding author

Keywords: polyurethanes, nanofillers, silicon oxide, iron oxide, detonation diamond, diamond charge, plasma, strength, elastic modulus.

Abstract

The studies carried out have shown the promise of surface modification of nano-sized fillers as a method for improving the characteristics of filled polyurethane systems. The article presents studies of the dependence of the conditions of plasma modification of nanodispersed fillers: silicon oxide (SiO_2), iron oxide (Fe_2O_3), detonation diamond (HA) and diamond charge (DS) on the strength and modulus of elasticity of polyurethane compositions with their use in an amount of up to 3 wt % . ~ 50% of the diamond charge is made up of ultradispersed detonation diamond with a primary crystal size of 4-6 nm, and the remaining 50% are so-called graphite-like structures.

In this case, the best characteristics are obtained when using air as a plasma-forming gas. Due to its composition (~ 78% nitrogen and ~ 21% oxygen), ionized air is capable of forming active functional groups on the surface, capable of interacting with n reactive groups of the polyurethane matrix.

Dependences of the strength and modulus of elasticity of polyurethane compositions on the power and time of exposure to low-temperature plasma are presented.

The change in characteristics from the modes of plasma modification is of a complex nature, difficult to describe by a mathematical apparatus. In this case, each individual factor, in particular the exposure time, is described with a high accuracy (R = 1) by a quadratic dependence. The nature of the modified dispersed filler also affects the formation of a new active surface, which is reflected in the difference in the dependences of the physical and mechanical characteristics on the time and intensity of plasma treatment.

As a result of the studies carried out, it was revealed that in order to increase the strength characteristics of polyurethane compositions using iron and silicon oxides, ultradispersed detonation diamond, as well as a diamond charge, detonation diamond in an amount of 0.65 % wt, treated with high-frequency plasma pulses for 20 minutes, should be considered optimal with a charge power of 2500 watts.

For citation: Tatyana V. Burdikova, Lyubov A. Zenitova, Sergey S. Ivshin. Influence of plasma treatment of dispersed fillers on the characteristics of a polyurethane matrix using them. *Butlerov Communications B.* **2021**. Vol.2. No.3. Id.8. DOI: 10.37952/ROI-jbc-B/21-2-3-8

References

[1] V.L. Mazurin. Polyurethane as a structural material of the XXI century. *Scientific and technical SPbSPU statements.* **2013**. No.2(171). P.165-170. L.A. Chizhova, G.P. Sigitova. The use of polyurethanes in composite materials. *Mater. X Int. stud. scientific. conf. "Student Scientific Forum".* Access point: http://scienceforum.ru/2018/article/2018005939. (Russian)

[2] V.A. Romanova, V.P. Begishev. Regulation of the properties of the polymer matrix based on polyurethane in the preparation of filled composite materials. *Composite Constructions. Mater.* **2006**. No.4. P.39-43. (Russian)

[3] A.K. Mikitaev, G.V. Kozlov. Description of the degree of reinforcement of nanocomposites by carbon nanotubes in the framework of percolation models. *Solid State Physics.* 2014. Vol.57. No.5. P.961-964. (Russian)

[4] S.M. Balaeva, G.V. Kozlov, G.E. Zaikov et al. Dependence of the degree of amplification on the structure of the nanofiller for nanocomposites polyurethane/carbon 68 nanotubes. *Bulletin of the Technological University.* **2015**. Vol.18. No.2. P.163-166. (Russian)

[5] S.A. Ryabov, E.A. Zakharychev, Yu.D. Semchikov. Investigation of the effect of the functionalization time of carbon nanotubes on the physical and mechanical properties of polymer nanocomposites based on them. *Bulletin of the Nizhny Novgorod University Named after N.I. Lobachevsky.* **2013**. No.2(1). P.71-74. (Russian)

[6] E.A. Vorobieva, K.E. Bachurin, A.V. Makunin et al. Synthesis and research of nanocomposites with the inclusion of carbon nanotubes. *Ecology and Medicine.* **2011**. P.127-132. (Russian)

[7] E.R. Badamshina, R.V. Goldstein, Yu.A. Olkhov, K.B. Ustinov, Ya.I. Estrin. Modeling the change in the mechanical properties of polyurethane elastomers upon modification with carbon nanotubes. *Phys. Mesomechanics.* **2012**. Vol.15. No.3. P.5-10. DOI: 10.24411 / 1683-805X2012-00035. 7.G (Russian)

[8] F.F. Komarov, M.A. Ksenofontov, R.M. Krivosheev, L.E. Ostrovskaya, O.V. Milchanin. Research of polyurethane filled with carbon nanoparticles. Applied Problems of Optics, Informatics, Radiophysics and Condensed Matter Physics: Proceedings of the Fourth Intern. scientific-practical Conf., Minsk, May 11-12, 2017 Ministry of Education Resp. Belarus, National Research University “Institute of Butt. physical problems to them. A. N. Sevchenko "Belarusian. state un-that; editorial board: V.I. Popechits (chief editor), Yu.I. Dudchik, G.A. Senkevich. *Minsk.* **2017**. P.252-254. Access point: http://elib.bsu.by/handle/123456789/178725 (Russian)

[9] I.A. Abdullin, S.S. Ivshin, Yu.I. Fedorov, E.F. Kravchenko. Influence of the addition of carbon nanotubes on the physical and mechanical characteristics of highly filled polymer systems. *Herald of Technological University.* **2016**. Vol.19. No.18. P.39-40. (Russian)

[10] S.A. Ryabov, A.E. Mineev. Study of polymer composites based on polyurethane binder and carbon nanotubes functionalized with methyldiethanolamine and triethanolamine. Innovations in the field of natural and mathematical sciences. *Collection of Scientific Papers on the Results of the International Scientific and Practical Conference. Ryazan.* **2017**. No.2. P.16-19. (Russian)

[11] N.V. Novikov. Detonation diamonds in Ukraine. G.P. Bogatyreva, M.N. Voloshin. *Solid State Physics.* **2004**. Vol.46. Iss.4. P.585-590. (Russian)

[12] G.I. Goryainov, O.N. Sarakuz. Modification of polyurethane elastomers by silicon-containing nanoparticles with hydroxyl functional groups. *Natural and Mathematical Sciences in the Modern World.* **2014**. No.18. P.199-206. (Russian)

[13] E.A. Sergeeva, V.S. Zheltukhin, I.Sh. Abdullin. Modification of synthetic fibrous materials and products by unequal low-temperature plasma Part 1: Theory, models, methods: monograph. *Kazan: Kazan Publishing House. Technol. University.* **2011**. 252p. (Russian)
[14] K.E. Perepelkin. Principles and methods of modifying fibers and fibrous materials (review). *Chem. Fibers.* **2005**. No.2. P.37-51. L. 2020. Vol.63. No.10 69. (Russian)
[15] L.A. Zenitova, E.A. Sergeeva, D.I. Fazylova. Influence of plasma modification on the structure and properties of polyester and polyamide cords. Perspective polymeric composite materials. Alternative technologies. Recycling. Application. Ecology. ("Composite-2010"): Proceedings of the V International Conference. *Saratov: SSTU.* **2010**. P.161-163. (Russian)
[16] I.Sh. Abdullin. High-frequency low-pressure discharges in plasma-chemical processes. *Herald of Technological University.* **2010**. No.4. P.172-186. (Russian)
[17] I.Sh. Abdullin, V.S. Zheltukhin, I.R. Sagbiev, M.F. Shaekhov. Modification of nanolayers in high-frequency low-pressure plasma. *Kazan: Kazan Publishing House. Technol. University.* **2007**. 356p. (Russian)
[18] I.Sh. Abdullin, V.S. Zheltukhin, N.F. Kashapov. High-frequency plasma jet treatment of materials at reduced pressures. Theory and practice of application. *Kazan: Kazan Publishing House. Technol. University.* **2000**. 348p. (Russian)
[19] T.V. Burdikova, L.A. Zenitova, S.S. Ivshin, A.A. Ivshina. Influence of nanodiamonds on the performance characteristics of filled composite materials. *Bulletin of Higher Educational Institutions, Series of Chemistry and Chemical Technology.* **2021**. Vol.64. Iss.5. P.57-62. (Russian)
[20] T.V. Burdikova, S.S. Ivshin, L.A. Zenitova. Study of the effect of metal nanooxides on the performance characteristics of composite materials based on polyurethanes. *Bulletin of Higher Educational Institutions, Series of Chemistry and Chemical Technology.* **2020**. Vol.63. Iss.10. P.64-70. (Russian)
[21] T.V. Burdikova, L.A. Zenitova, S.S. Ivshin, A.A. Ivshina. Strengthening of composite materials of power plant housings. Special communication and information security: technology, production, management. Proceedings of the 9th International Scientific Symposium. Russia, Krasnodar - pos. Terskol, Kabardino-Balkarian Republic, April 23-30, 2021/under the general editorship of prof. A.M. Popov. *Moscow: FGBNU "Analytical Center" of the Ministry of Education and Science of Russia.* **2021**. P.99-101. (Russian)
[22] T.V. Burdikova, L.A. Zenitova, S.S. Ivshin, A.A. Ivshina. Influence of ultra and nanodispersed additives on the performance characteristics of composite materials based on polyurethanes. Environmental, industrial and energy safety – 2020: collection of articles based on the materials of the international scientific and practical conference "Environmental, Industrial and Energy Security – 2020" (September 14-17, 2020). ed. G.V. Kucherik, Yu.A. Omelchuk. *Sevastopol: SevGU.* **2020**. P.111-116. (Russian)
[23] I.V. Kovalevskaya, T.R. Safiullina, L.A. Zenitova, V.A. Frantsuzova. TGA and DSC methods in the study of thermal stability and filled polyurethanes of the SKU-OM type. *Herald of Technological University.* **2013**. No.12. P.126-129. (Russian)
[24] Tatyana V. Burdikova, Lyubov A. Zenitova, Sergey S. Ivshin. Influence of plasma treatment of dispersed fillers on the characteristics of a polyurethane matrix using them. *Butlerov Communications.* **2021**. Vol.68. No.10. P.156-163. DOI: 10.37952/ROI-jbc-01/21-68-10-156 (Russian)