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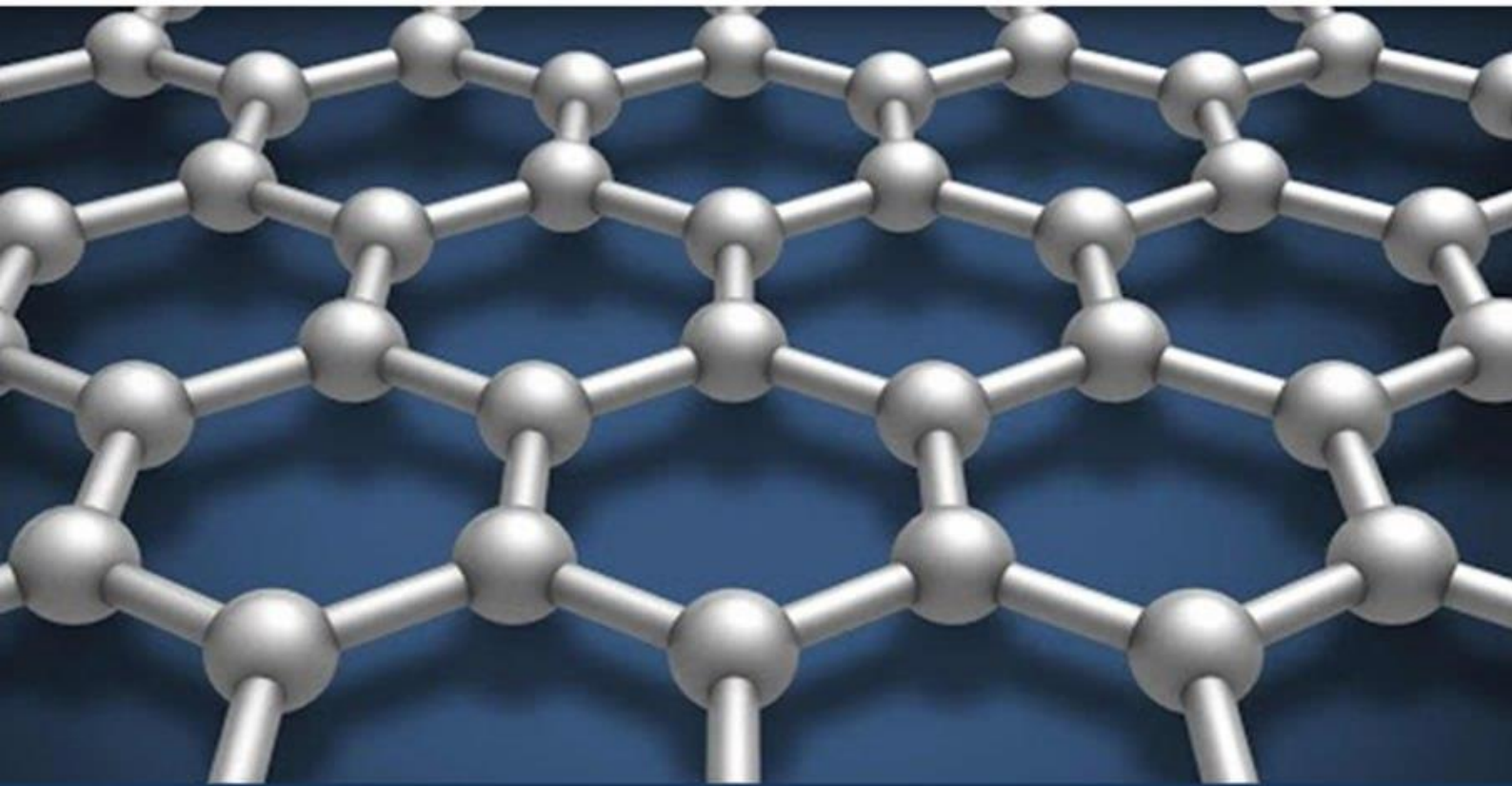
Kompozitsion Materiallar

Ilmiy-texnikaviy va amaliy jurnali



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Композиционные материалы

9. Рашид М.Ф., Рахим А., Ирфан-уль-Хасан М., Али Б., Али Н. Серный бетон, изготовленный из отходов мрамора и шлаковых порошков: 100% переработанный и безводный бетон. Environ Sci Pollut Res Int 2022, 29(43): 65655-65669. https://doi.org/10.1007/s11356-022-20456-y
10. Сабур М.Р., Дезваре Г.А., Ниавол К.П. Применение методов искусственного интеллекта при моделировании коррозии цемента и серобетона в канализационных системах. Процессы окружающей среды 2021, 8: 1601-1618. https://doi.org/10.1007/s40710-021-00542-y
11. Шахсавари М.Х., Кербала М.М., Иранфар С., Вандегинсте В. Механические и химические свойства марсианского и лунного серобетона с учетом ингредиентов реголита и сублимации. Constr Build Mater 2022, 350: 128914. https://doi.org/10.1016/j.conbuildmat.2022.128914

KEY REQUIREMENTS ON OBTAINING HIGH-PERFORMANCE ALUMINUM OXIDE-BASED CERAMICS

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Introduction. In essence, ceramics are inorganic materials that vary in their microstructures, which can be mostly semi-crystalline (like carbides) or entirely amorphous (like glass). Ceramics have been used in artifacts, pottery, and other items since ancient times. Nonetheless, throughout the ages, ceramics have changed and developed into what are now generally referred to as "Traditional Ceramics" and "Advanced Ceramics," from being hard, brittle, low fracture strength, and insulators to tough, high shock resistant, flame retardant, and conductive. "Structural Ceramics," also referred to as "Engineering Ceramics," is a significant and extensively studied class of advanced ceramics. Ceramic materials used to fabricate various hard structures subjected to mechanical, thermal, tribological, or chemical loads fall under this category. Structural ceramics are appropriate for a wide range of applications because they can withstand large loads and temperature changes while maintaining their shape, mechanical strength, and dimensions. Structural ceramics also have the advantage of having a composition that can be customized through a variety of processing methods [1].

Alumina-based ceramics can also be included in this group of ceramic materials. Alumina-based ceramics are widely used in various fields of industry like abrasives, refractories, internal combustion engine parts, biomedical implants, electronics, the tooling industry, the military, and so on because they are more common in nature than others and also due to the advantages of several properties [2].

Aluminum oxide modifications. There is no doubt that the properties of alumina depend on the modifications that occur at various temperatures and acquire different crystal structures. There are resistant (α, β, and γ (hexagonal and cubic lattice)) and non-resistant (δ hexagonal and θ monoclinic) modifications of aluminum oxide. β – Al_2O_3 is not considered a pure modification of aluminum oxide. Its presence in corundum (α-Al_2O_3) reduces its strength. Bauxite is considered the main ore to manufacture γ modification of aluminum oxide which is called technical alumina, and it mainly consists of γ - Al_2O_3 and other additives. Since it is difficult to produce high-quality parts of technical alumina, they are heated to a temperature of 1500-1750 °C, where the content of alumina changes from γ - Al_2O_3 to α - Al_2O_3 [3].

Requirements on aluminum oxide based materials. The property, microstructure, and production technology are the main factors that determine the performance of alumina-based ceramics and these factors are related to each other too and this concept is considered a main discipline of materials science [4].

The production technology of ceramic materials is in many ways similar to the technology of hard alloys, and both technologies are based on the use of raw powder materials, their grinding (dispersion), pressing (compaction), and are based on sintering processes that provide a unique structure, technological properties, specified physical and mechanical properties. However, there are a large number of defects in polycrystalline materials, and these defects occur at various stages of technological processing. It is important to improve existing ceramic technologies to reduce the size and concentration of these defects, which affect the quality of ceramic materials. The following important factors should be taken into account in the technology of obtaining high-quality ceramic materials [5]:

- High dispersion of initial components;
- Quality mixing of powders;

- Quality mechanical-chemical activation of powders;
- Optimization of the pressing process (ensuring that the sample has a high density and an even distribution of this density);
- Optimizing the sintering process (which allows obtaining fine-grained and almost non-porous material).

The low density, high thermal stability, mechanical strength, hardness, high melting point, biocompatibility, inertness to most acids and alkalis, adsorption capacity, wear resistance, oxidation, electrical insulation, and non-toxic of alumina are considered the main advantages of this type of ceramic materials. Those high mechanical, physical, and chemical properties of aluminum oxide are related to bonding energy between aluminum and oxygen which is considered about 582 kJ/mol. The use of powder metallurgy methods in the production of ceramic materials based on aluminum oxide provides an opportunity to obtain details with a unique structure and complex properties. The main properties that determine the quality of aluminum oxide-based ceramics as engineering material [6]:

- Hardness is a property that depends on the hardness of the main phase of the material and its composition;
- Strength is a property that depends on the structure of the material, and also depends on the size of the crystals, the composition of the phase, and the state of various substances between the phases;
- Fracture toughness - this property depends on the breakdown energy and structure of the material.

The main objective of today's researchers is to obtain an optimal ratio between these three properties by applying various research methods. As we know the performance and properties of materials are related to microstructure for all material types. So, if we want to make high-performance alumina, there should be requirements on the microstructure which are as follows [5]:

- The high density of the material
- The solid boundary between phases and grains
- The constituents of the structure should be fine-grained (dispersed) and evenly distributed (homogeneity)
- The minimum size of defects in the composition (may cause a decrease in mechanical properties)
- Absence of easily soluble constituents in the composition (reducing the strength of the material at high temperatures);
- High hardness and resistance to crack propagation (improving resistivity of dynamic forces).

Conclusion. To manufacture alumina-based ceramics with high performance, some important factors like the modification type, microstructure, production process, and essential properties of alumina should be taken into account. All these factors are related to each other and determine the performance of detail parts based on aluminum oxide.

REFERENCES:

1. Dilraj Preet Kaur, Seema Raj, Meena Bhandari, Chapter 2 - Recent advances in structural ceramics. In Elsevier Series on Advanced Ceramic Materials, Advanced Ceramics for Versatile Interdisciplinary Applications, Elsevier, 2022, Pages 15-39, ISBN 9780323899529. https://doi.org/10.1016/B978-0-323-89952-9.00008-7.
2. Hami, Hawraa & Abbas, Ruba & Eltayef, Emad & Ibrahem, Neda. (2020). Applications of aluminum oxide and nano aluminum oxide as adsorbents: review. Samarra Journal of Pure and Applied Science, 2. Pp: 19-32.
3. Abizov, A.M. (2019). Oksid aluminiya va alyumoksidnaya keramika(Obzor). Chast 1. Svoystva Al_2O_3 va promyshlennoe proizvodstvo dispersnogo Al_2O_3. Nauchnie isledovanie i razrabotki. №1, 2019. Pp: 16-23.
4. Callister, W. D., & Rethwisch, D. G. (2017). Materials Science and Engineering: An introduction. Tenth edition. Wiley, Hoboken, NJ, 2020. ISBN: 978-1-119-45520-2.
5. Gnesin, G.G., Osipova, I.I., Rontal, G.D., Samoylov, V.S., Yaroshenko, V.P. Keramicheskie instrumentalnie materiali [Ceramic tool materials]. 1991. ISBN: 5-335-00451-7.
6. C. Barry Carter, M. Grant Norton. Ceramic Materials: Science and Engineering. Springer New York, NY. 978-1-4614-3523-5Published: 04 January 2013. Edition 2. https://doi.org/10.1007/978-1-4614-3523-5

Kalit so’zlar: Aluminiy oksid, xossalar, modifikatsiya, ishlab chiqarish, mikrostruktura.

Aluminiy oksid asosli keramik materiallar o’ziga xos xossalarga ega bo’lishi ushbu turdagi materiallarga bo’lgan talabning yildan yilga ortib borishini taqozo qilmoqda va bu esa ushbu materiallardan turli masuliyatli sohalarda ya’ni keskichlar, elektronika, kosmonavtika, avtomobilsozlik va boshqa sohalarda qo’llanilishiga imkon beradi. Ushbu maqola aluminiy oksid asosidagi keramik materiallarni ishlab chiqarish

5. Методы исследовании, приборов и оборудований композиционных материалов

6. Проблемные обзоры

7. Вести из лаборатории