

LIMITED LIABILITY SOCIETY «NANOCOM»

OKPD-2 24.45.30.390

Group B56  
(OKS 77.160)



ACCEPTED

General Director  
NANOCOM LLC  
Oleg Neyaglov  
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MODIFIER POWDER QUASICRYSTALLINE  
TECHNICAL CONDITIONS  
TC № 24.45.30-005-31800065-2018  
Introduced for the first time

DEVELOPED:  
NANOCOM LLC

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## INTRODUCTION

These technical conditions (hereinafter referred to as TC) apply to the powder modifier quasicrystalline (hereinafter referred to as the modifier, product). The modifier is intended for use in composite materials, polymers, rubbers, adhesives, paint and varnish systems, in friction units of mechanisms with oil lubrication, in babbits.

### In friction units of mechanisms with oil lubrication:

- reduces friction losses (reduces temperature and noise of the friction pair operating under load);
- prevents the dragging and jamming of the friction pair elements;
- increases the time of emergency operation of machines and mechanisms in the conditions of oil loss and in the mode of "dry" friction.

### In polymers:

- increases strength characteristics of polymers;
  - increases the adhesion of the polymer matrix to the reinforcing elements of polymer composite materials (PCM);
  - increases the strength of polymer composite materials and plastics.
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### In polytetrafluoroethylene (PTFE, Teflon):

- increases the wear resistance of the material in 2200-3100 times (at a concentration of 16 vol.%).

### In rubber:

- increases the strength characteristics of rubbers up to 25%;
- increases adhesion to metals to a level exceeding cohesion (destruction occurs on the rubber, peeling from the metal is absent).

### In the glue:

- increases the strength of the glue;
- increases the adhesion of the adhesive to the surfaces to be glued.

### In paint and varnish systems:

- increases adhesion to painted surfaces;
- increases the wear resistance of the paintwork.

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**In metal composite materials:**

- improves the strength characteristics;
- reduces the coefficient of friction.

**In the coating:**

- reduces the coefficient of friction;
- increases the level of hydrophobicity of surface coatings.

**In babbits:**

- significantly increases mechanical properties of babbites without deterioration of tribological properties of the material.

The general designation of the modifier brand is MPQ (Modifier powder quasicrystalline) [-X1] [X2], where:

- MPQ - Modifier powder quasicrystalline;
- X1 - designation of the size index of the product in relation to the passage of the sieve with a cell of the appropriate size in microns.
- X2 - designation of the content of the quasicrystalline phase (N - normal, more than 80 mass%, the rest of the impurity, P - higher, more than 95 mass%, the rest of the impurity).

X1, X2 designated as necessary

For example:

MPQ-40P - denotes a modifier powder quasicrystalline of high purity with a quasicrystalline phase content of more than 95 mass %, past 1 sieve with a 40 µm cell. At the same time, the product contains particles from nanoscale sizes to 40 µm with a normal size distribution.

MPQ-25N - designates a modifier powder quasicrystalline of normal purity with a quasicrystalline phase content of more than 80 mass%, passed 1 sieve with a 25 µm cell. The product contains particles from nanometers up to 25 µm with a normal distribution sizes.

The example of the reference number:

"Modifier powder quasicrystalline. MPQ -40. Technical conditions - TU24.45.30-005-31800065-2018"

The list of normative documents. The link in this documents is given in Appendix A.

**1. TECHNICAL REQUIREMENTS**

The product is manufactured in accordance with the requirements of the present technical specifications and the design documentation of process regulations for manufacturing of this product, approved in due course.

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## 1.1 Key Features and Parameters

1.1.1 The main technical parameters are listed in the Table 1.

**Table 1.**

Name of the indicator	Norm
Appearance	Powder
Color	Black
Density (g/sm3)	4
the dispersion of the base powder on the passage of the sieve, microns, $\mu\text{m}$	1-40
The steel friction coefficient, HV	0,14
Thermal conductivity (W/(m*K))	2
Resistivity (at room temperature $t^{\circ}\text{C}$ ) $\text{mOm}^*\text{cm}$	4,5
Temperature stability in a non-oxidized environment, $^{\circ}\text{C}$	850-900
Temperature of onset of intense oxidation in air, $^{\circ}\text{C}$	600
Note: it is possible to obtain a modifier of various dispersity, up to nanoscale	

1.1.2 The appearance of the modifier is shown in Picture 1.

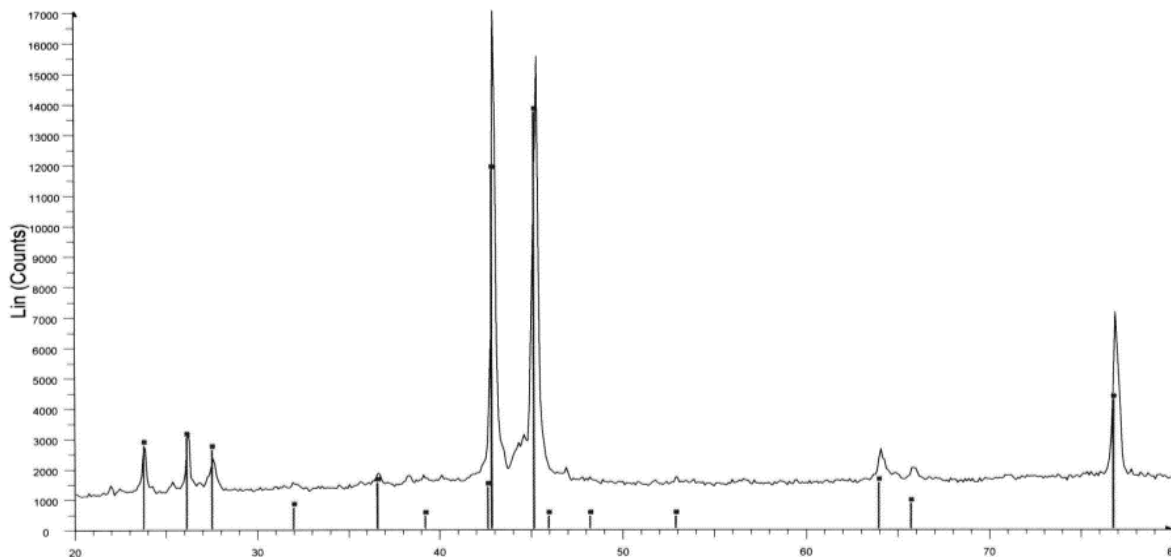


Picture 1 – The appearance of the modifier

1.1.3 All modifier brands should contain a quasicrystal system Al-Cu-Fe as the main phase in the form of quasicrystal compounds  $\text{Al}_7\text{Cu}_2\text{Fe}$ ,  $\text{Al}_{65}\text{Cu}_{20}\text{Fe}_{15}$ ,  $\text{Al}_{65}\text{Cu}_{22}\text{Fe}_{13}$ ,  $\text{Al}_{65}\text{Cu}_{23}\text{Fe}_{12}$  in any mutual ratios.

1.1.4 The presence of impurities in the form of ternary or binary intermetallic compounds in the Al-Cu-Fe system is possible.

The reference diffractogram of the  $\text{Al}_{65}\text{Cu}_{20}\text{Fe}_{15}$  quasicrystal is shown in Picture 2.



Picture 2 - Reference diffractogram of Al<sub>65</sub>Cu<sub>20</sub>Fe<sub>15</sub> quasicrystal

## 1.2 Material and raw materials requirements

1.2.1 The components (substances) from which the products are manufactured must comply with the requirements of the regulatory documentation that is grown on them and be suitable for use.

1.2.2 For the manufacture of the modifier the powder of aluminum (brand PAD-1), copper (brand PMS-1) and iron (brand PZH) are used.

## 1.3 Marking

1.3.1 Each unit of shipping container should be marked according to GOST 14192.

1.3.2 Upon delivery, the marking is applied directly (on the container and (or) on the label with indelible paint.

The label must contain the following information:

- is the trademark or manufacturer's name;
- the symbol or name of the product
- batch number;
- date of manufacture;
- Net weight;.

1.3.3 The marking must be made in Russian or another language according to the supply agreement. Marking shall be maintained throughout the entire delivery period until used by the Customer.

1.3.4 Transport marking in accordance with GOST 14192.

## 1.4 Packing

1.4.1. All packaging must comply with the requirements of the Technical Regulations of the Customs Union TR TS 005/2011 "Regarding packaging safety".

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1.4.2 Products are packed in plastic containers in accordance with GOST 33756, GOST R 52620 in volumes from 0,1 to 50 liters, and in metal barrels in accordance with GOST 13950 in volumes from 50 to 100 liters.

1.4.3 Before use, transport packaging should be checked for purity and the absence of other materials.

1.4.4 It is allowed, by agreement between the manufacturer and the customer, to use other types of packaging that ensure the safety of products during transportation and storage.

It is allowed to use import shipping containers that meet the established requirements.

1.4.5 Technical and shipping documentation must be packaged in a plastic film bag in accordance with the requirements of the Technical Regulations of the Customs Union TR TS 005/20 1 “Regarding packaging safety”, or shipped without packaging as agreed with the customer.

## 2. SAFETY AND ENVIRONMENTAL REQUIREMENTS

2.1. The modifier is non-flammable, odorless, non-toxic.

2.2. When working with a powder modifier, it is necessary to comply with safety regulations that are appropriate for working with powders of different dispersion and safety rules for receiving, transporting, using ferrous and non-ferrous metals and alloys based on these melts.

2.3. Work with the modifier should be carried out in accordance with the requirements of current safety standards, regulatory and technical documents on specific modifiers, as well as a system of occupational safety standards and approved hygienic standards.

2.4. Modifier is a low hazard substance and belongs to the 4th hazard class according to GOST 12.1.007.

2.5. Control over the sanitary parameters of production and the environment is carried out in accordance with the sanitary rules № 1.1.1058.

2.6. Production premises should be equipped with mechanical supply and exhaust ventilation, ensuring the concentration of harmful substances in the air of the working area, not exceeding the maximum permissible according to the hygienic standards of GN 2.2.5.1313. The ventilation system of industrial, warehouse and auxiliary premises must meet the requirements of GOST 12.4.021.

2.7 Production staff should be provided with special clothing and personal protective equipment in accordance with GOST 2.4.011 and typical industry standards.

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2.8 Personnel employed in the production of the modifier, job with it, must undergo preliminary on admission to work and periodic medical examinations in accordance with the order of the Ministry of Health № 302, dated 12.04.2011

2.9 General requirements for ensuring fire safety in production - according to GOST 12.1.004 and according to the fire safety standards of NPB105.

2.10 Environmental protection - according to GOST 17.2.3.01: emissions of harmful substances into the atmosphere - according to GOST I 7.2.3.02 and SanPiN Sanitary Regulations & Standards 2.1.6.1032; there is no waste water in the production of the modifier.

2.11 Disposal of waste - according to sanitary rules and standards SanPiN 2.1.7.1321.

2.12 Under normal environmental conditions, the modifier does not release harmful chemicals into the environment in quantities exceeding the maximum permissible concentrations approved by sanitary authorities.

2.13 After the use of the modifier in the enterprise of the consumer, the packaging in which the products were packaged must be disposed in accordance with the requirements of current sanitary norms and rules.

### 3. RULES OF ACCEPTANCE

3.1 The modifier is accepted by the technical control service of the enterprise of the producer.

3.2 Acceptance of the modifier is carried out in batches. The batch is the quantity of products obtained from materials of constant quality using a single technology, accompanied by one quality document. The Volume must be written in a regulatory or technical document for a modifier.

3.3 The frequency of monitoring the physicochemical properties and the values of standardized quality indicators ensuring technological and technical efficiency in all fields of application are established by the manufacturer.

3.4 The quality certificate shall contain:

- trademark or manufacturer's name; modifier brand;
- batch number and date of manufacture;
- net weight of a batch;

-the name of the regulatory or technical document in accordance with which the modifier is made.

3.5. The consumer has the right, when accepting production, to conduct a control check of its quality for all standardized indicators stipulated in the regulatory or technical document.

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3.6. In case of detection of hidden defects (a defect not detected using standard methods and means of control or diagnostics, but identified during the technological process / involvement in production) when the modifier is involved in production, the entire batch is delayed and is recognized as inappropriate until the end of the material retest according to the rejected characteristic, regardless of the results of the input control.

#### 4. CONTROL METHODS

4.1 Selection and preparation of samples - according to GOST 23148.

4.2 The appearance and color of the modifier are monitored by visual inspection.

4.3. Dispersion is determined by the method of sieve fractionation.

The control means is a sieve with a 40 µm cell. Passed control is the product "-40", fully past the specified sieve.

4.4 Bulk density is determined according to GOST 19440 using a funnel with an outlet diameter of 5 mm.

4.5. Friction coefficient - according to GOST 11629.

4.6. Hardness is determined according to GOST 25698, GOST 20017, GOST 25172.

4.7. Thermal conductivity is determined by the current regulatory or technical document.

4.8 Specific resistance is determined according to GOST 25947.

4.9. The phase composition of the modifier is determined by X-ray phase analysis. The control means is an X-ray diffractometer, in the database of which the main quasicrystal compounds are present. The past control is a product containing as the main phase a quasicrystal of the Al-Cu-Fe system in the form of quasicrystalline compounds  $Al_7Cu_2Fe$ ,  $Al_{65}Cu_{20}Fe_{15}$ ,  $Al_{65}Cu_{22}Fe_{13}$ ,  $Al_{65}Cu_{23}Fe_{12}$  in any mutual ratios.

4.10 The specific surface of the modifier is determined by gas adsorption. The device of control is a specific surface analyzer.

4.11 The particle size distribution of the powder is determined by various methods. The control device is a particle analyzer.

4.12 The type of particles is determined by scanning electron microscopy. The control device is a scanning electron microscope.

#### 5. TRANSPORTATION AND STORAGE

5.1 The modifier is transported by any type of transport in accordance with the rules for the carriage of goods, appropriate for a particular type of transport.

5.2 Containers intended for transporting products must be clean and dry. When reused, if necessary, the container is steamed, washed and dried.

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5.3 When transporting products, it must be protected from precipitation, as well as the safety of the container with the modifier from mechanical damage.

5.4 The shelf life of the modifier (under the condition of the safety of the container) is unlimited.

## 6. MANUFACTURER'S WARRANTY

6.1 The manufacturer guarantees the conformity of products to the requirements of this technical specification, TU 24.45.30-001-31800065-2018, under the conditions of transportation and storage.

## 7. RECOMMENDATIONS FOR USE

7.1 It is recommended to use the modifier as an additive containing from 1 to 5 mass %, depending on the application.

7.2 The consumer determines the specific value of the modifier content.

7.3 A necessary condition for the effective operation of the modifier is its uniform distribution by volume of the modified material. The presence of bunches and conglomerates of the modifier in the volume of the modified material is unacceptable.

7.4 In the case of active mixing of the modified material during operation, the modifier can be added directly to as a concentrated suspension based on a modified material or solvent, compatible with the modified material, in the amount of the modified material.

7.5 In systems equipped with filters, the dispersion of the powder modifier should provide its particles with a common passage through filter element.

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## Appendix A

### List of regulatory documentation

Standard number	Standard name
Order of the Federal Service for Environmental, Technological and Nuclear Supervision dated December 30, 2013 N 656 "On approval of Federal norms and rules in the field of industrial safety" Safety rules for receiving, transportation, use of ferrous and non-ferrous metals and alloys based on these melts "	
GOST 12.1.004-91	Occupational Safety Standards System. Fire safety. General requirements.
GOST 12.1.018-93	Occupational Safety Standards System (OSSS). Fire and explosion safety of static electricity. General requirements
GOST 12.1.045-84	Occupational Safety Standards System (OSSS). Electrostatic fields. Permissible workplace levels and inspection requirements
GOST 12.4.011-89	Occupational Safety Standards System (OSSS). Means of protection of workers. General requirements and classification
GOST 12.4.021-75	Occupational Safety Standards System (OSSS). Ventilation systems. General requirements
GOST 12.4.121-2015	Occupational Safety Standards System (OSSS). Personal respiratory protection. Filter masks. General technical conditions
GOST 12.4.124-83	Occupational Safety Standards System (OSSS). Remedies against static electricity. General technical requirements
GOST 12.4.253-2013	(EN 166: 2002) Occupational Safety Standards System (OSSS). Personal eye protection. General technical requirements
GOST 17.2.3.01-86	Nature Protection. Atmosphere. The rules of air quality control of populated areas
GOST 17.2.3.02-2014	Rules for determining the allowable emissions of pollutants by industrial enterprises
GOST 11629-2017	Plastics. Method for determining of friction coefficient
GOST 13950-91	Steel welded and sunset barrels with corrugations on the body. Technical conditions
GOST 14192-96	Cargo Marking
GOST 19440-94	Metallic powders. Determination of bulk density. Part 1. The funnel method. Part 2. Scott volumetric method

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GOST 20017-74	(ST SEV 2003-79, ISO 3738 / 1-82) Solid sintered alloys. Rockwell Hardness Method
GOST 23148-98	(ISO 3954-77) Powders used in powder metallurgy. Sample selection
GOST 25172-82	(ISO 3878-83) Solid sintered alloys. Vickers Hardness Method
GOST 25698-98	(ISO 4498-1-90) Sintered metal materials, excluding hardmetals. Determination of the apparent hardness of materials with generally uniform hardness over the cross section
GOST 25947-83	(ST SEV 3914-82) Solid sintered alloys. Method for determination of electrical resistivity
GOST 33756-2016	Polymer consumer packaging. General technical conditions
SP 1.1.1058-01	Organization and holding of production control over the observance of sanitary regulations and the implementation of sanitary and anti-epidemic (preventive) measures
SP 4783-88	Sanitary regulations for the production of synthetic polymeric materials and enterprises for their processing
SP 2.2.2.1327-03	Hygienic requirements for the organization of technological processes to production equipment and working tools
SanPiN (Sanitary Regulations & Standards) 2.1.6.1032-01	Hygienic requirements for air quality in populated areas.
SanPiN 2.1.7.1322-03	Hygienic requirements for the placement and disposal of production and consumption waste
SanPiN 2.2.4.548-96	Hygienic requirements for the microclimate of industrial premises
NPB 105-2003	Definition of categories of premises, buildings and outdoor installations for explosion and fire hazard
GN 2.2.5.1313-03	Maximum permissible concentration of harmful substances in the air of the working area
TR TS 005/2011	Technical Regulations of the Customs Union "About packaging safety"

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