# PREPARATION OF MULTI-COMPONENT POWDER OF ANY HIGH SOLIDS PROCESS

## ТЕХНОЛОГИЯ ПОЛУЧЕНИЯ УЛЬТРАДИСПЕРСНЫХ ПОРОШКОВ ВЫСОКОСКОРОСТНЫМ СПОСОБОМ

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**Abstract:** *The possibility of obtaining ultra-disperse powders by high speed way with a particle size that does not exceed the declared value. The research of the mechanical method of obtaining ultra-disperse powders. Dispersion of obtained powder was defined for various materials. The dependence of the dispersion of the obtained powder was indentified from the choice of abrasive tools on Bakelite and metal bonds.*

**KEYWORDS:** *NANO- AND ULTRA-DISPERSE POWDER, HIGH SPEED WAY, MECHANICAL METHOD, ABRASIVE DISK, LIQUID NITROGEN*

Currently, the key factor of economic development and national defense capability is the development of new materials, their processing and use. Current direction of development of modern science is to provide nano- and ultrafine powders of various metals and study their properties. Because ultrafine particle size powders have unique combinations of chemical, electrical, magnetic, radio-mechanical and other properties that determine new functionality, constructional and operational characteristics. The structure of the powder has a significant effect on the properties, depending on the production method [1]. There are following requirements for the methods:

1) The high speed of forming of particles birth centre and the low speed of their growth;

2) The provision of temporary stability of the particles, the surface protection from spontaneous oxidation and sintering in the manufacturing process;

3) Preparation of the particles or grains of a prescribed size;

4) Effective production and efficiency;

5) Control of the parameters [2,3].

Methods of preparation of nano- and ultrafine materials are divided into physical, chemical, biological and mechanical.

The main methods of mechanical grinding are crushing and grinding of solid materials, melt dispersion, processing of solid (compact) materials by cutting. Mechanical methods are based on the effects of large deforming stresses: dragging, pressure, pressing, vibration, cavitation processes and etc. [4].

Mills of various types are applied for the mechanical grinding of solids: planetary, ball, ink, swirl, vibration and others. Due to the fact that in the preparation of ultrafine and nano powders grinding work is proportional to the surface area, it is necessary to use high power mills [2].

The main advantages of using a mechanical method of grinding (mills) are:

1) Preparation of nano and ultrafine powders of multicomponent alloys in a single step;
2) The ability to grind various materials and produce alloys powders in large quantities;
3) The relative simplicity of the technology.

Disadvantages of the mechanical methods:

1) The size distribution of the particles and the variety of forms;

2) The difficulty of controlling the composition of the product during grinding;

3) The more complex components and accuracy the factor of merit, the harder it is to control the metal structure, and the higher the cost of the production;

4) The possibility of contamination of nano and ultrafine powders with the attrition of grinding bodies or working bodies of mills [5.6].

The mechanical method is promising for the development of nano- and ultrafine powders of multicomponent alloys, however, for a more efficient use of it, knowledge of the physical processes occurring during mechanical stresses are very useful [7,8]. Therefore, it’s necessary to determine the possibility of a high-speed method and experimental study of the processes occurring in solids in the manufacture of powders [9]. Installation, applied in the experiment, represents the mill.

Processing of the material was carried out at the circumferential speed of the grinding disk up to 300 m / s, while the synchronistic rotational and reciprocating motions of the workpiece. The grinding wheel was used as the grinding disc with abrasive elements (abrasive head with diameter of 12 mm). The workpiece carried order was about 1 mm / min while feeding nitrogen from the cryogen reservoir through the thermohose to the work zone was about 1 l/ min. The particle sizes of the powder were regulated by circumferential speed of the grinding disc, choice of abrasive heads and workpiece supply [10].

The workpiece set coaxially to one of abrasive heads in the clamping device was rotated. After reaching predetermined rotational speed by the grinding disc, the workpiece was continuously cooled with liquid nitrogen during the whole abrasion process. Grinding wheel was linked up with workpiece until the contact, whereby the workpiece was grinding by abrasion. The powder was removed from the grinding chamber, using a blowing trap of the particles, connected to a device for collecting ground product. After abrasion of the workpiece, the device was disconnected, the ground material was removed from the collection device, set a new workpiece (Figure 1) [11].

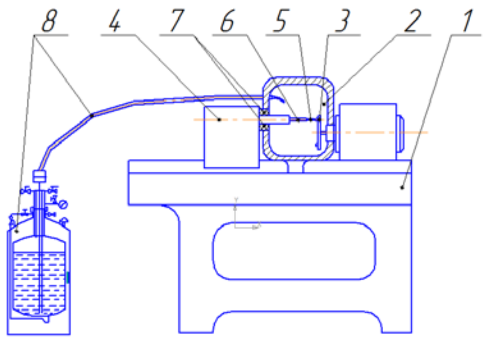


***Fig. 1.*** *Installation scheme: 1 – frame; 2 - airtight enclosure; 3-abrasive wheel; 4-work feeder; 5-workpiece; 6-work holder; 7- airproof cell; 8- feeder of liquid nitrogen to the work zone.*

Experiments were carried out with materials having different hardness, friability, toughness (Fig. 2) [12,13].

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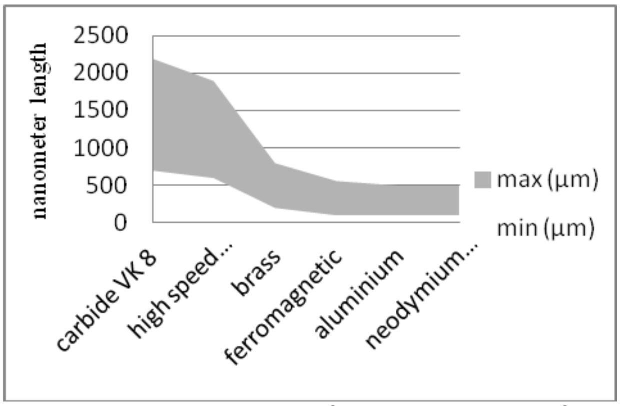
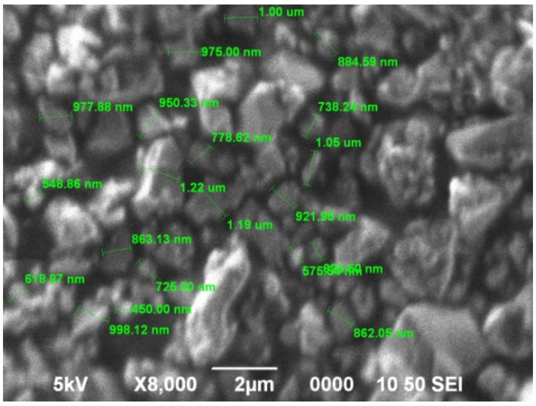



***Fig. 2*** *The dispersion of the obtained powder of variety materials*

The collected powders had a particle size in the range from 100 nm to 1.5 microns (Fig. 3). The average particle size of the steel powder VK8 was 1100 nm, HSS P18 - 950 nm, of brass - of 400 nm from a ferromagnet - 280 nm. The best results were obtained with powders of aluminum and neodymium magnet (Fig. 3c).

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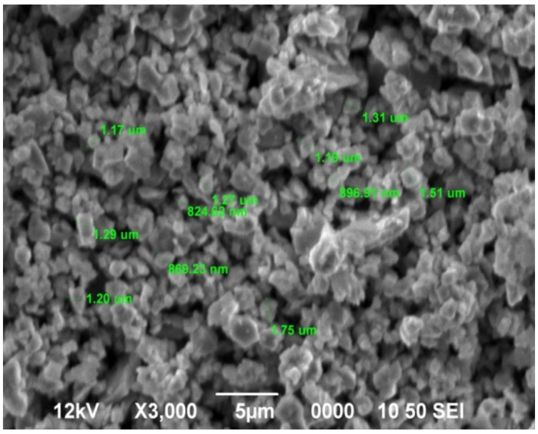


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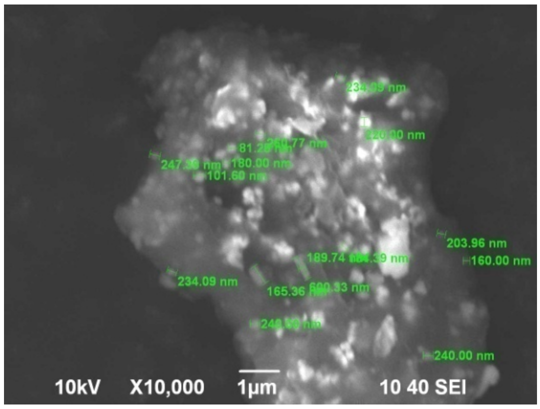


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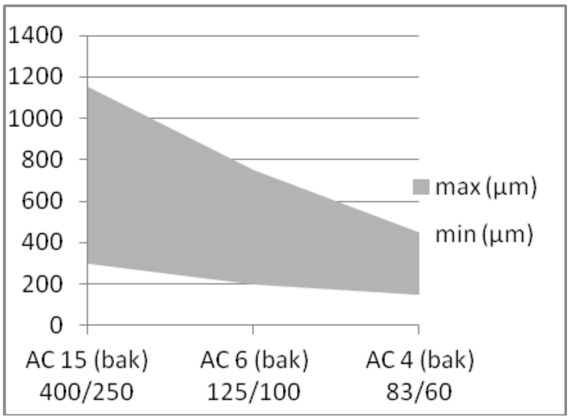
***Fig. 3*** *The dispersion of the obtained alloy powder P18 (a), alloy VK 8(b), neodymium magnet (c).*

During the experiments were used abrasive elements on the bakelite and metal bonds.

From the obtained data follows that the variation in the dispersion decreases with decreasing of grain of abrasive elements range (Fig. 4).

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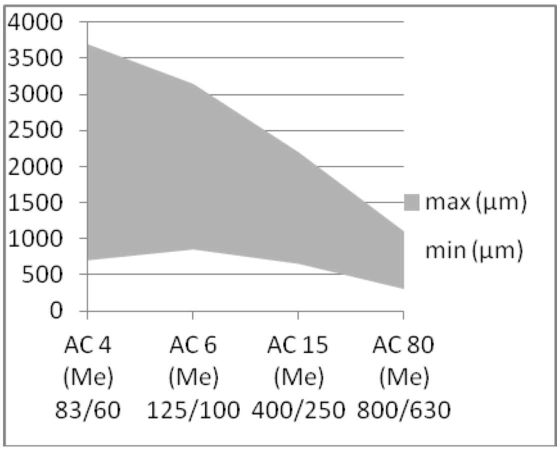


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***Fig 4.*** *The dependence of the dispersion of the obtained powder by the choice of grinding tool on bakelite bond (a) and metal bond (b).*

The mechanical processing method with using of a grinding wheel provides wasteless processing of the workpiece, reducing the spread of sizes and the possibility of obtaining particles less than 0.1 mm. Adding liquid nitrogen reduces the occurrence of high temperatures generated by abrasion at high speeds, thus decreasing the fire hazard in the work [14,15,16].

The detection of the dispersion dependence of obtained powder from the material, from which it was derived, as well as the choice of abrasive tools - undoubtedly important. More important will be to identify the dependence of different properties of the material on dispersion of the obtained powder for understanding the fundamentals and principles of high-speed particles chipping from different material from abrasive elements. It is also necessary to investigate the properties of the obtained powder of a magnetic material on X-ray apparatus for determining the magnetic properties, compared with the starting material.

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