



AVIS
GLOBAL GROUP

*I never think of the future.
It comes soon enough.*

Albert Einstein

VORTEX MINING TECHNOLOGY



CERAMIC
STONES
GLASS
BIOMASS
COAL
ANY METAL





AVIS acquired the tornado patent technology with AVIS Nano Tech in 2016 for the conversion of crude waste unsorted to Nano Powder for the 3 D printing technology

By that time, eleven industrial models of resonant-Vortex "TORNADO" units (lines) were designed for the disintegration, as well as mechanical activation of mineral raw materials, super hard materials, biomass, polymers, oxides and carbides of metals and their multicomponent mixtures with Nano structuring. Technologies were obtained, capable of crystal disclosure of ore raw materials and beneficiation of columbite (tantalum-niobium), quartzites (includes gold), shale graphite (platinum); ilmenite and titanium- magnetite (titanium oxide), pyrite cinder (copper, rare earth metals), some technogenic tailings of the mining industry from more than 30 countries; a mobile mining installation - "Tornado-M" has been created with the capacity of 1 ton/hour of ore and concentrates processing; more than 40 types of metallic micro powders were received, micro powders of ceramics, abrasives, composites and polymers, new materials, nanostructured materials and functionalized carbon nanostructures.



In Spain AVIS construct its first high volume for 5.000.000 metric tons crude unsorted municipal and industrial trash. The plant should start its operation by the end of 2018.

PURED OUTPUT PRODUCTS

TITAN + a plant for the production of metal powders and micro powders and ceramic metal magnetic powders and powders for special 3D-Printing.

BIO + a plant for biotechnology, focused on the production of biologically active substances (BAS) from vegetable raw materials, biological crop protection and nutritional supplements.

POLIMER + a plant for deep processing of lignin-containing raw material, production of new polymer materials, BAS and biofuels.

CERAMIC + a plant for production of mineral micron powders, pigments, metallic powders for 3D-Printing, activated and functionalized building mixes, additives in concrete.

PRECIOUS METALS like gold, silver extracted direct from the mining. The gold containing rocks must be cut in 8 cm diameter and treated with the industrial Vortex. 15 metric tons each hour applications available.

UNSORTED WASTE treatment plant for municipal, industrial and toxic waste is a reach source of prime material for new composite structures for 3D-Printing.



MINING TECHNOLOGIES WITH VORTEX

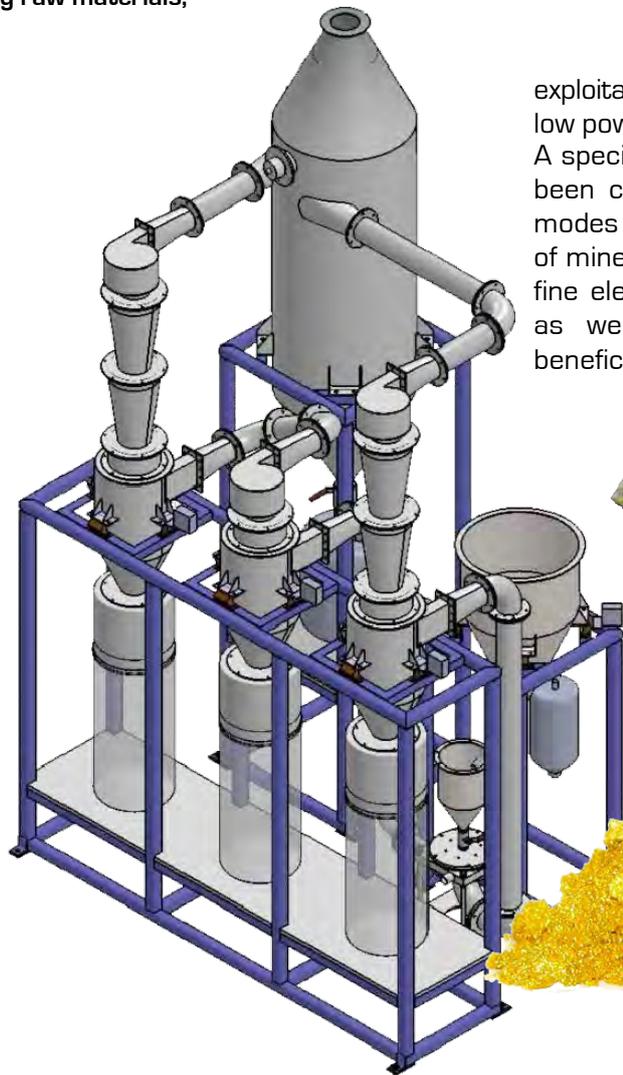
Mining technologies, "dry" methods of beneficiation; Geological exploration and extraction of mineral resources;

Disintegration and dispersion of mineral raw materials, production of mineral powders and pigments; New methods of useful elements extraction from ore concentrates; Mobile processing "Tornado" plants with a capacity of 1 ton/hour processing raw materials;

A new technology is being used in the resonant vortex "Tornado" installation, a non-contact material grinding, where the grinding processes are performed by means of an air vortex, artificially produced in an enclosed space within the processing chamber. As an energy carrier (fuel), the following may be used:

pressurized air (compressor or a turbine); any inert gas supplied under pressure; high-pressured steam (superheated steam); supercritical media (fluids), for instance (CO₂), refrigerants

The resonant vortex "Tornado" installation is a gas-dynamic mill in which the technology of cascaded adiabatic resonance impact grinding is implemented, impact velocities of which are close to a breakdown threshold. The installation is designed in a way so that any particle of the input material gets literally torn by the repeated crossing of the differential pressure zones in the intervortex vacuum chamber, which produce ultrahigh gradient (pressure drops) up to hundreds of thousands of atmospheres. When the input material is inserted into such area of pressure differential, a rupture of the material's structure and clusters occurs. Such mechanism can be compared to the mechanism of material's sample destruction, which is done in order to determine its strength characteristics at tensile test plants. That is, the grinding occurs not due to the friction or any other mechanic force, but by "air" and resonances, which provide a high and efficient performance, great flow rate of raw material as well as inexpensive



exploitation (no rubbing parts) with low power consumption. A special "Tornado" installation has been constructed, where different modes of detection and disclosure of mineral aggregates consisting in fine elements are being examined, as well as methods of further beneficiation.



from Gold Ore to Gold Nano-Powder



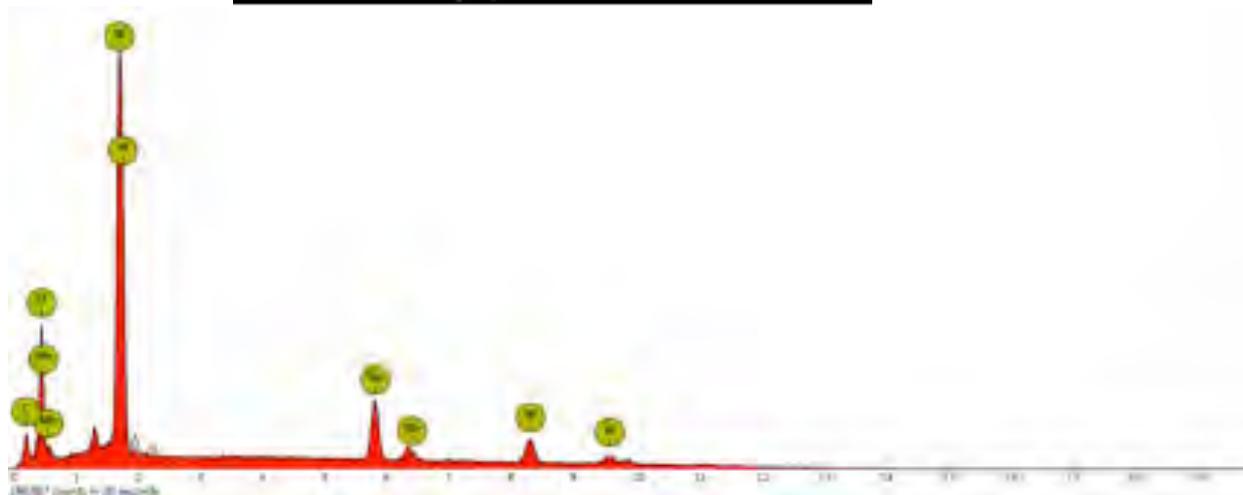
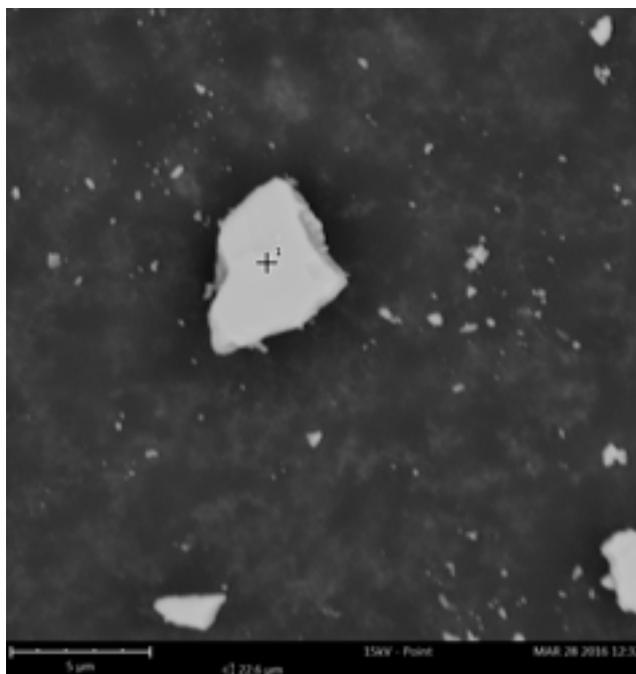
to ...

GOLD 3D PRINTING TECHNOLOGY



Some results of the application based on resonant vortex installation "Tornado" for mineral samples of concentrates and industrial stocks from different countries.

Deposit in Russia. Disclosure of a splice crystal of wolframite (W-Mn) from the mineral impurities at the level of 2-3 microns. The detection rate of 100%.



Element Number	Element Symbol	Element Name	Weight Concentration	Error
8	O	Oxygen	9.2	0.0
25	Mn	Manganese	5.8	0.2
74	W	Tungsten	80.9	0.3
6	C	Carbon	4.1	0.6

Note: With the practical results of work on the possibilities of "dry" enrichment can be found by visiting the pilot plant

TECHNOLOGY of obtaining solid solutions of metals by mechanic synthesis and their activation in the "Tornado" installation.

Summary.

The industrial production of homogeneous disperse mixtures (alloys) directly between the constituent components in the solid phase, avoiding the stage of their meltdown, became possible with the resonant-vortex installation "Tornado" in one step.

Methods were developed for the following:

- metal-carbon, carbon-metal;
- intermetallic compounds;
- multi-component mixtures;
- carbides, metal carbides, binary carbides, multiphase ceramics, carbides, with the insertion of atoms;
- 3D- mixtures, mixtures for plasma spraying and powder metallurgy;
- mixtures for super-strong multi-pole magnets and so on.

The "Tornado" installation is designed in a way so that any particle of the input material gets literally torn by the repeated crossing of the differential pressure zones in the intervortex vacuum chamber, which produces ultrahigh gradient (pressure drops) at the interface (up to hundreds of thousands of atmospheres). When the material is injected into such area of pressure differential, a rupture of the material's structure and clusters occurs. Such mechanism can be compared to the mechanism of material's sample destruction, which is done in order to determine its strength characteristics at tensile test plants. That is, the grinding occurs not due to the friction or any other mechanic force, but by "air" and resonances, which provide a high and efficient performance, great flow rate of raw material as well as inexpensive exploitation (no rubbing parts) with low power consumption.

In the process of solid mixtures grinding within the working chamber of the "Tornado", occurs an accelerated process of mass transfer and chemical interaction between the components with no thermal effects. The process can be influenced by reagents. In the formation of compact samples obtained from the activated micro powders by hot pressing, a further homogenization of the material in which the matrix of micro-heterogeneity of the solid solution amounts to about 0.2 weight %, The pressing temperature is reduced and the sample density is increased.

The study of the process within the working chamber showed that one-step activation occurs, and almost at the same time, according to the scheme: dispersion - mechanical mixing - chemical interaction between which there are no clear boundaries.

Examples of the mechanically activated micro powders: TiC+ZrC + diamond micro powders, compounds Al₂O₃ - Cr₂O₃, titanium carbide-nickel, oxides as modifier for

resins, polyethylenes that increase the physico-chemical properties (Nano-dimension and ultra 0.1 to 1 micron) - TiO₂, ZrO₂, Cr₂O₃, Fe₂O₃, Fe₃O₄, CoO, NiO, CuO, ZrO₂-Y₂O₃, BaTiO₃, Li(Na)MO₂, P₃92Ti(Zr) 2O, Y₃Al₃O₁₂; Ni₇₀Al₃₀; NiCr₂₀Ti_{2,5}Al; SiO₂, GeO₂; Ni-Cr-B-Si-C; SmCo₅, Ni₄₅Co₅Mn₄₀Sn₁₀; HF-Ta-C, AlSi₁₂, AlSi₁₀Cu, AlZn₁₀Si₈Mg, and etc.

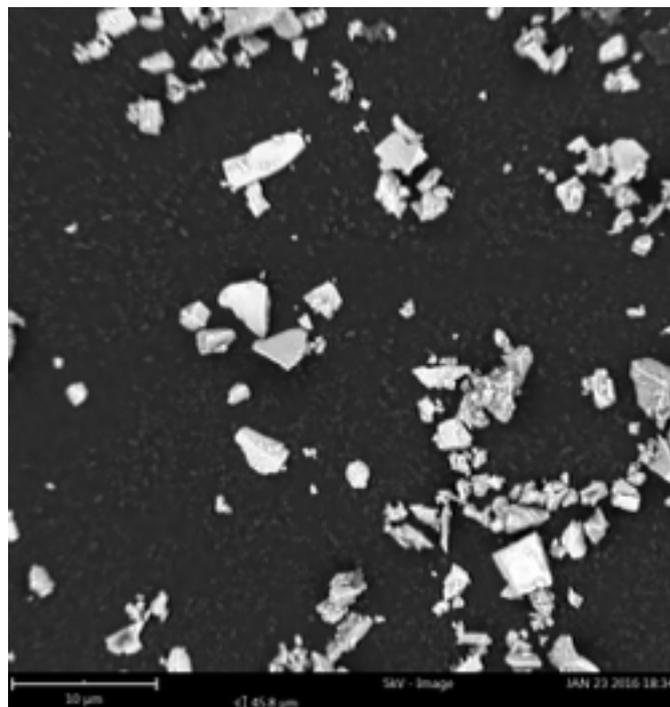
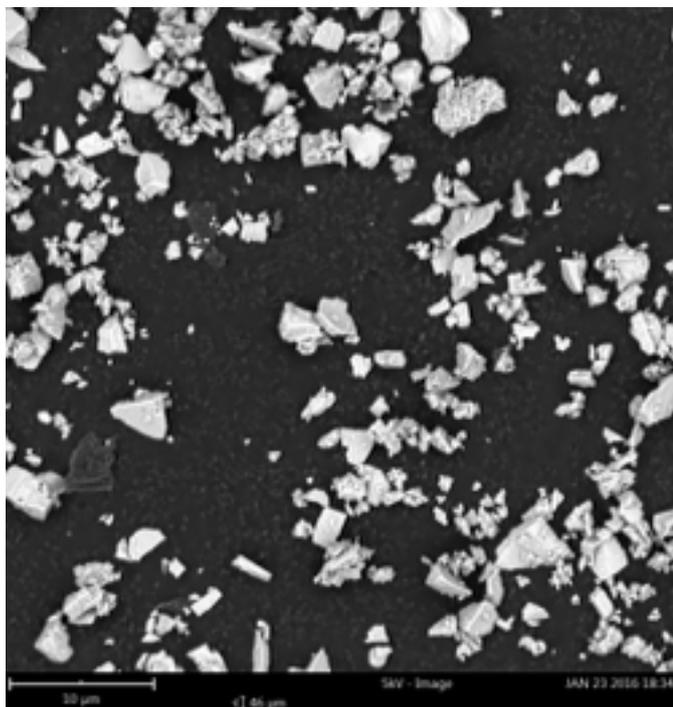
Particularly interesting is the application of the technology of producing micro and Nano-dispersed powders, the so-called pseudo alloys that are difficult or impossible to obtain by the traditional melting of the components. Therefore, pseudo alloys are acquired in other ways, in particular by sintering of the powder components. The physico-mechanical and operational properties of the pseudo alloys are superior to the traditional alloys of similar purpose. Often, a high level of specialized magnetic, nuclear (radiation), electric and other properties can be ensured only by pseudo alloys. The intensification of the operational impact and, above all, the temperature, leads to the need of developing high-temperature materials based on refractory metals - tungsten, tantalum, molybdenum and niobium. Thus, the technology of highly dispersed "Tornado" powders production has increased physical and mechanical properties of pseudo alloys W-Fe-Ni and Mo-Cu which are of special purpose.

The parameters of the microstructure, defects of the crystalline structure and phase composition of the mechanically activated mixtures for the systems W- Ni-Fe and Mo-Cu were identified, as well as the optimal regimes of the mechanical activation of these systems. A positive result from the use of the Nano powders is the formation of a fine-grained structure of sintered materials. The industrial technology of production of electric-pseudo alloy

Mo - Cu for gas-insulated switches, superior in its characteristics in contrast to all the world analogues. During the research, it was revealed that the mechanical activation is not limited to a simple increase of the free-surface, it is always accompanied by a change of the physical state, chemical properties and composition of the grinded material. Ultrafine grinding is accompanied by a change of defects of the crystalline structure, up to the complete amorphization of the substance. This creates an "aftereffect" due to the fact that the grinded material possesses "excess" energy that was accumulated during the grinding process. These processes facilitate the functionalization of homogeneous and also carbon structures, such as metal inoculation.

Practical results of work on resonant vortex "Tornado" installation.

Grinding of titanium carbide (TiC) for plasma spraying. Input material dimension of 2-4 mm. Output: $d_{50} = 3,5 \mu\text{m}$ (microns), - free of impurities.

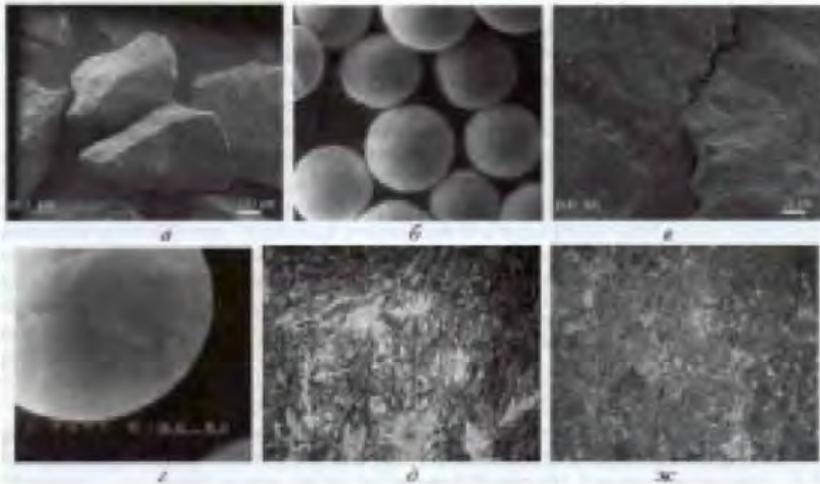


Grinding of titanium carbide (TiC) for powder and laser metallurgy. Input material dimension of 2-4 mm. Output: $d_{50} = 20 \mu\text{m}$ (microns), - free of impurities.

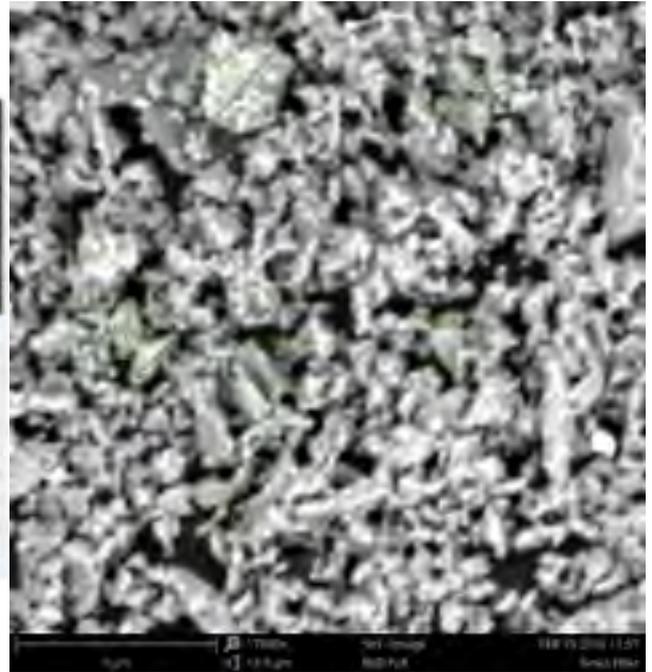


Practical results of work on resonant vortex "Tornado" installation.

The general form of powders of tungsten carbide (WC), obtained with different technologies: a, b - crushing after casting; b,r - after spraying; d, w - the microstructure of tungsten carbide after disintegration in the "Tornado".



WC, d90 = 1,5 µm



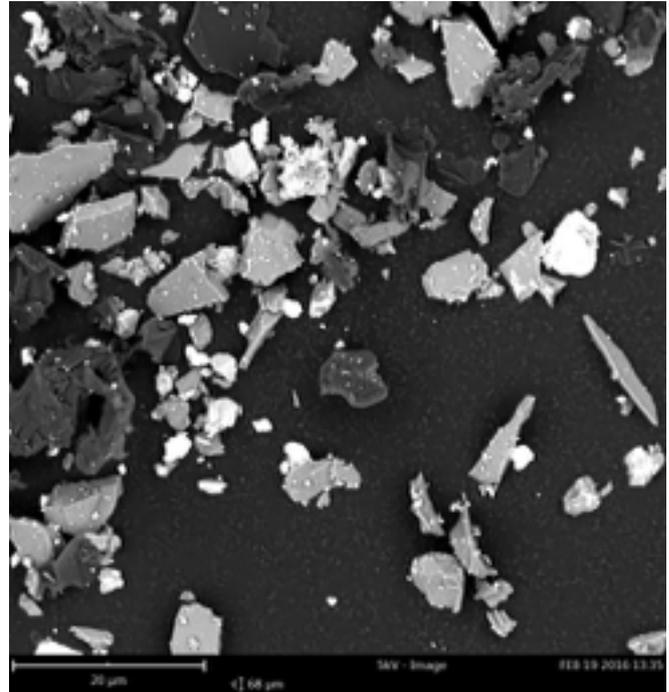
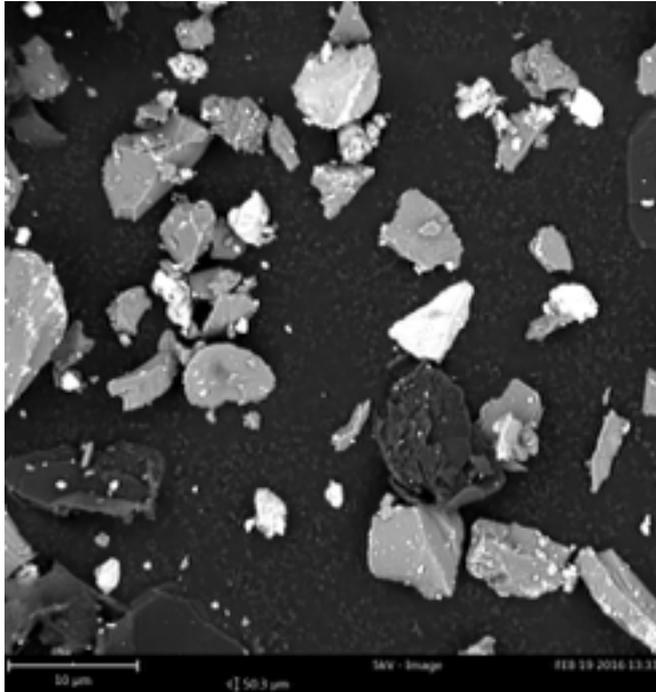
conclusion: for the same fraction of the spherical powder and the powder milled in Tornado, the specific surface crushed in the Tornado, is times higher than the spherical due to the extensive surface of the particle. Such surface occurs due to the rupture of particles during the grinding in Tornado. Mechanochemical activation in Tornado shows better mechanophysical indicators of multicomponent compositions with their high density, which has a beneficial effect in relation to the finished product.

Grinding of tungsten metal in an inert environment installation "Tornado". d50 = 22 µm (micron),
- free of impurities.

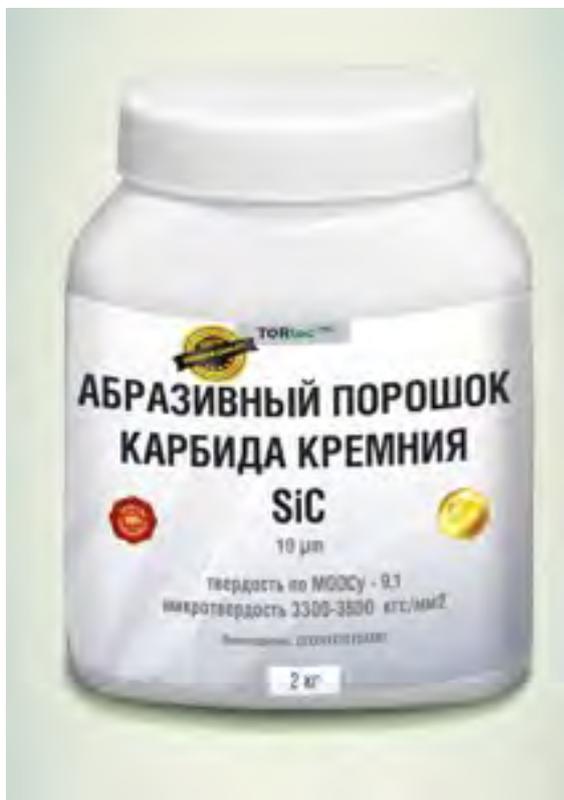


Practical results of work on resonant vortex "Tornado" installation.

Silicon carbide (SiC), d50 = 5 µm and d50 = 10 µm.

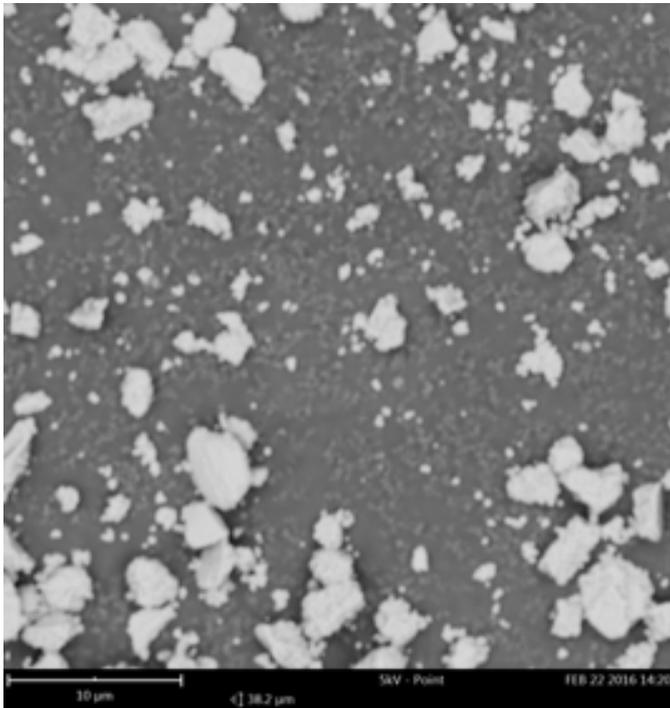


Grinding of silicon carbide at the "Tornado". d50 = 5 and 10 µm (microns) size reduction without impurities.

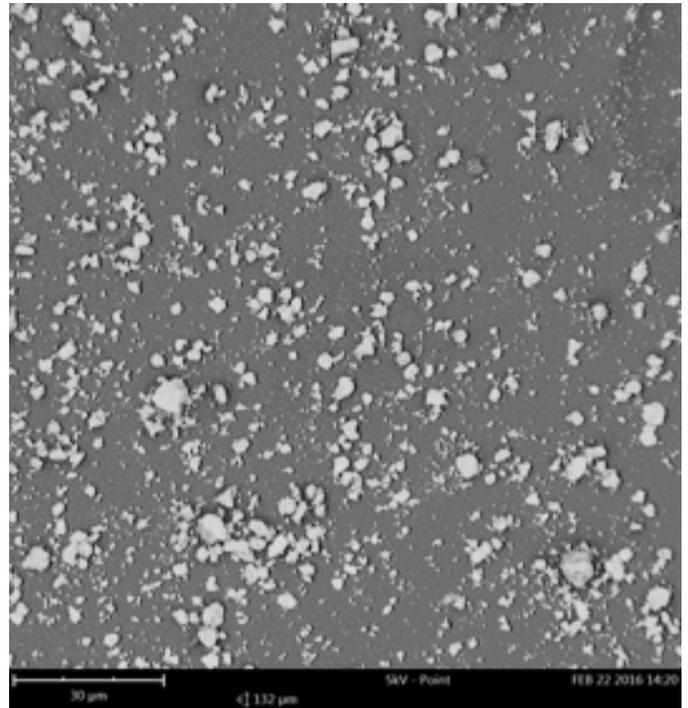


PRACTICAL RESULTS OF OUTPUT PRODUCTS AT THE RESONANT VORTEX "TORNADO" INSTALLATION.

Zirconium oxide (ZrO_2) 99,98 d97 = 5 μm .



d97 = 10 μm .

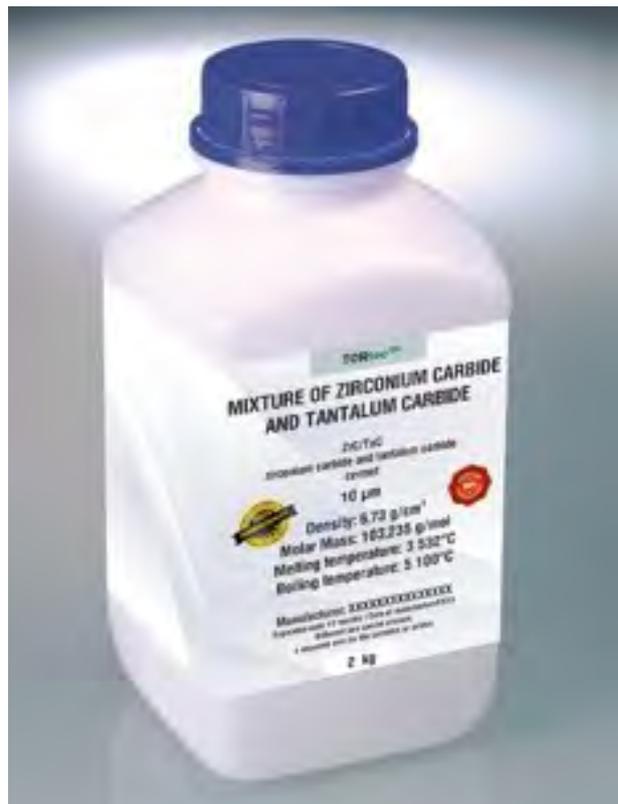


The grinding of dental Zirconium at the "Tornado". d97 = 5 and 10 μm (microns), - free of impurities.



10 μm
2 kg
260,- EUR

OUTPUT PRODUCT EXAMPLES FOR 3D PRINT



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