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Polycrystalline material, method for the production thereof and articles made therefrom

1. Field of the invention.

The invention relates to the field of new high-durable materials, namely to the monophasic polycrystalline material based on zirconium dioxide of tetragonal modification and to the method of its production by the method of high-frequency melting in a cold container.

Besides, the invention relates to the processing and wear-durable articles working at increased loads, and also to the cutting instruments, used in medicine and which should have high strength, wear-durability and longevity and which are produced of the crystalline material.

2. Description of the Related Art.

Materials based on zirconium dioxide have unique physical and mechanical characteristics: high hardness, wear- durability, and at the same time high viscosity and plasticity. It is known that apart from chemical nature, characteristics of these materials are determined by their macro and micro structure, which is formed both as a result of topochemical processes in initial materials (dehydration, recrystallization in a gradient temperature field, etc.) and depending on a method of obtaining the material (sintering, pressing or melting) and also as a result of changes of technological parameters of the used method. For example, to obtain material representing zirconium ceramics, methods of sintering and isostatic compression are used, and to obtain zirconium material having crystalline structure, different modifications of high-temperature melting are used.

The choice of the method of obtaining the material and equipment are determined by characteristics of initial compounds and obtained material, and also by demands made on the finished products, such as cleanliness, defectiveness, structure, size, etc. As a rule for more economical use of the material it is tried to be obtained of a larger size and more suitable shape, because when preparing the crystalline material, wastes after cutting, grinding and polishing can be up to 80% of the initial material.

There is known a material based on zirconium (hafnium) dioxide stabilized with 10-30% of yttrium oxide (US Patent Document No. 4153469, pub. 08.05.79). The material represents a monocrystal of cubic modification of zirconium (hafnium) dioxide, and it is optically transparent. A monocrystalline structure of the material ensures its high microhardness



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(1300-1500 kG/mmI), but it causes a higher fragility and low viscosity and durability. It limits its wide use in industry.

To obtain the above-mentioned monocrystalline material on US Patent Document No. 4153469 the method of direct high-frequency (HF) melting in a cold container is used. For this purpose the initial charge consisting of zirconium or hafnium dioxide and stabilizing yttrium oxide with a fixed proportion, is placed into a reactionary container and melted by using an electric field of high frequency. Then from the obtained colourless melt a monocrystal is grown by withdrawing the container with the melt from the melting zone at a speed of 2-30 mm per hour. When the container is being removed from the melting zone the growth of the monocrystals in a form of their monocrystalline lump begins. Then the lump is easily divided into separate monocrystals.

The method allows to obtain material, representing cubic monocrystals of stabilized zirconium or hafnium with a height of up to 8 cm and a cross section of 0.5 to 4.0 cmI.

To obtain a coloured material a colouring oxide, selected from the group of oxides of transition or rare-earth elements, is added into the charge in an amount of up to 8 mol.%.

There is known a ceramic material containing (mol%): 96-98 of ZrO_2 and 2-4 of Y_2O_3 or 6-13 of CeO_2 . The basis of the material (up to 90%) is formed by zirconium dioxide of tetragonal modification (JP Appl. 62-30660 (A_2) pub. 09.02.87 Kokai Toko Koho). The material represents a sintered ceramics and consists of grains of irregular shape with a size of not more than 0.1 μm . This ceramics has high hardness, bending strength and viscosity. But because of the monoclinal phase of zirconium dioxide and submicropores on the border of the grains, the grains crumble out. It increases fragility of the material and decreases its wear-durability.

To obtain ceramics it is necessary to reduce the powders of oxides, which the ceramics consists of, to small dispersive fragments 0.1 μm in size, to grind them in water, to add polyvinilstirol and mix thoroughly. Of the obtained shliker the press-powder is produced by pulverizing drying and then is formed at pressure of 3 t/cmI. After the link is burnt out, the half-finished product is sintered for an hour at 1480°C, then condensed by the method of hot isostatic pressing at temperature of 1400°C and pressure of 1500atm (JP Appl. 62-30660 (A_2) pub. 09.02.87 Kokai Toko Koho).

The obtained ceramics has Vicker's hardness – 1600 kG/mmI and a bending strength of 600-900 MPa at 20°C.

Above technology of producing ceramics does not make it possible to get material with a high density, and consequently with a sufficient mechanical durability of ceramic material. Also the problem is obtaining of the initial powder with the even granule-metric composition all over the volume and even distribution of the stabilizing oxide in zirconium dioxide.

Besides, because of tetragonal-monoclinal transformation during sintering and especially during isostatic compression a surface layer with a strain of compression arises. It causes admixture of monoclinal phase of zirconium dioxide in the material and also surface crumbling because of pulling out of the ceramic grains when using material. And it decreases its wear-durability.

It is known that material based on ZrO_2 of partially stabilized 2,5- 3.5 mol% yttrium oxide has high hardness and viscosity (Martinez-Fernandez J., Jimenez Melendo M., Domingues-Rodriguez A., Heuer A.H. "Microindentation-induced transformation in 3.5 mol%-yttria-partially-stabilized zirconia single crystal" J. Am. Ceram. Soc. 1991, p. 491). But presented monocrystals have not a big size (10x5x3 mm). They were obtained by the method of growing from melt in garnisage as insertions into the cubic modification of zirconium dioxide and were used for examining hardness of the monocrystal of tetragonal modification of zirconium dioxide in different directions.

There is known material based on ZrO_2 of partially stabilized 2.5-3.5 mol% yttrium oxide (RU Appl. 97112489, pub. 10.08.99). The material is obtained by melting in garnisage. The charge, consisting of ZrO_2 and Y_2O_3 is loaded into the container with cooling walls and melted forming melt in garnisage. Crystallization of the melt is effected by moving the container in vertical direction relatively to the inductor. Gradually lowering inductor power the container is cooled to temperature of 1200-1400°C, and when the inductor is switched off to room temperature. Annealing of the obtained material is carried out in the open air at temperature of 800-1400°C for 1-10 hours or in discharged atmosphere at pressure of $10^{-4} - 10^{-1}$ mm mercury and temperature of 1100-2100°C for 1-20 hours.

The known method leads to obtaining of the material, which microstructure represents chaotically situated domains, having irregular shape and size of 100-200 nm (0.0001-0.0002 mm).

At expense of decrease of structure granularity wear-durability of the material is increased. But such ultradispersive structure leads to strain surface layer with high strain of compression. It decreases resistance of the material to the beginning of cracking, and also it is a conductive factor for possible transformation of the tetragonal phase into the monoclinal one.

It is known that increased tendency of the material to development of the surface cracks is testified by a higher index of crack strength, determined at room temperature by method of chevron cut in comparison with the same index, determined by method of ball pressing (Fisher G. Zirconia: Ceramic Engineering's toughness challenge. Am. Cer. Soc., Bull. 1986, 65, No. 10, 1355-1360). For this material these indicators are 17 MPa/ml and 11 MPa/ml correspondingly.

As a rule high-temperature method of synthesis of materials based on stabilized zirconium dioxide is effected by melting in HF field in the container with cooled walls, in which crystals are grown in vertical direction.

At vertical growth of the crystalline substance thermal convection is difficult. It leads to a partial seizure of melt and admixture drops, which accumulate in intercrystalline grains and decrease strength and wear-durability of the material. Besides, the vertical method of obtaining material does not allow polycrystalline material of a large size necessary in industry.

There are known shaving blades, produced of ceramic material containing not less than 90% of tetragonal zirconium dioxide and 2-4 mol% of yttrium oxide (JP Appl. 62-30660 (A₂) pub. 09.02.87 Kokai Toko Koho). But the heterogeneous structure of the material, containing admixture of monoclinical phase of zirconium dioxide, does not insure high wear-durability and strength of the blades.

There are known blades, produced of monocrystal of diamond, sapphire or other substance similar to diamond (US Patent Document No. 5317938). But they are expensive, fragile and can be produced only of a small size (not more than 10.0 mm).

Blades, produced of the material with domain structure are the closest to the claimed ones (RU Appl. 97112489 pub. 10.08.99). But the structure of the material does not insure sufficient wear-durability of the blades.

3. Summary of the invention.

Technical task of the invention is to create a polycrystalline material with a structure, which would allow to increase resistance of the material to the beginning of cracking, bend strength and wear-durability of the material, when using it for producing cutting edges and high-durable articles.

Above task is achieved by obtaining material, consisting of crystallites of partially stabilized zirconium dioxide of a needle or plate shape with a size not more than 0.05 mm, ration of the length to the maximum cross section not less than 2:1, the crystallites arrange parallel to their long axes and form rectangular lattice.

As a stabilizing oxide the material contains oxide, selected from the group of oxides of yttrium, cerium, magnesium, calcium.

It is expediently, if the material contains chromoforous ions such as rare-earth cations and polyvalent cations of transition metals, selected from the group: cobalt, titan, chrome, aluminium, vanadium, manganese, iron, nickel, neodymium, lantern, praseodymium, cerium, samarium, europium, gadolinium, erbium, thulium, ytterbium and lutetium. These ions give the material different colour. The amount of the chromoforous additives in the material is not more than 5 mol%.

To give the material black colour, it is expediently to treat it thermally at temperature of 1650-1750°C for not less than 3 hours.

The task is achieved by realizing the proposed method of obtaining the material with the claimed structure. According to this method the charge, consisting of zirconium dioxide and stabilizing oxide is loaded into the cooled container and melted. The sample is crystallized. The container is cooled to temperature of 1300-1400°C by lowering inductor power. The melt is held for not less than 3 hours before the process of crystallization. Crystallization and cooling of the container to temperature of 1300-1400°C are carried out at pressure, lowered to 200-300 mm mercury. Then cooling to room temperature is carried out by gradual increasing of pressure for not less than 24 hours. The whole process is effected by moving container in horizontal direction relatively to the inductor.

It is expediently to effect the repeated melting at a speed of not more than 100 mm per hour after cooling the melt to 1300-1400°C.

For preparing the charge zirconium dioxide can be used both as a powder and as crystals and as waste of monocrystalline production.

It is preferably as a stabilizing oxide to put into the charge an oxide of metal, selected from the group of oxides of yttrium, cerium, magnesium, calcium.

To obtain a coloured metal it is preferably to put into the charge colouring chromoforous cation of the metal, selected from the group of transition or rare-earth elements (cobalt, titan, chrome, aluminium, vanadium, manganese, iron, nickel, neodymium, lantan, praseodymium, cerium, samarium, europium, gadolinium, erbium, thulium, ytterbium and lutetium) in an amount of up to 5mol%.

As a rule to obtain the material, oxides of the metals containing not more than 10^{-2} % of admixtures are used.

It is preferably to effect annealing of the obtained material at temperature of 600-1400°C or at temperature of 1100-2000°C and pressure lowered to 10^{-4} – 10^{-1} mm mercury for 1-20 hours.

Above task is achieved by the cutting instruments which are produced of the polycrystalline material, consisting of crystallites of partially stabilized zirconium dioxide of tetragonal modification and having a needle or plate shape, a height of not more than 0.05 mm, ration of the height to the maximum cross section not less than 2:1, the crystallites arrange parallel to their long axes and form rectangular lattice.

4. Brief description of the drawings.

In fig. 1 there is a photo of the claimed material structure. The photo is made by the petrographical polarization microscope at 1000-multiple magnification.

In fig. 2 there is the diagram of the equipment used for realizing the method of obtaining the polycrystalline material.

In fig. 3 there is A-A cross-section of the container/

In fig. 4 there is the picture of the material obtained in conditions of atmospheric pressure.

In fig. 5-7 there are samples of medical scalpels, which blades are produced of the claimed material.

In fig. 8, 9 there are two types of blades sharpening.

In fig. 10-13 there are photos of the production – medical scalpels of different profiles with the blades of the claimed material.

5. Description of the preferred embodiments.

There is the structure of the claimed material on the photo in fig.1. The photo is made by the petrographical polarization microscope at 1000-multiple magnification.

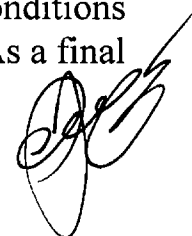
According to the X-ray phase examination the crystallites represent monocrystals of partially stabilized zirconium dioxide of tetragonal modification. It confirms indices of interplane parameters from the table, calculated according to the X-ray phase analysis, which was carried out on diffractometer ДРОН-1 in Cu-radiation with a graphite monochromator. The sample is ground into powder and sown.

Table

$$a=b=5.10 \text{ \AA}, c=5.16 \text{ \AA}, V=134.2$$

I/I ₀	D _{exp}	h	K	L
100	2.95	1	1	1
27	2.57	0	0	2
42	2.55	2	0	0
77	1.812	2	0	2
33	1.803	2	2	0
14	1.554	1	1	3
25	1.542	3	1	1
8	1.480	2	2	2
7	1.275	4	0	0
16	1.177	3	1	3

It is ascertained that the claimed material has homogeneous, monophase structure without any surface cracks. Under the microscope numerous cuts of the material, made in all directions give the picture of rectangular lattice, as it is shown in fig.1. Such structure of the material ensures surface resistance to strain of compression and conditions resistance to development and spreading of the destroying cracks. As a final



result it leads to increase of the material resistibility to the beginning of cracking. Above conclusion is confirmed by almost the same indices of break strength, determined by method of cutting (17MPa/ml) and method of ball pressing (16MPa/ml).

Experimentally it is ascertained that if the size of the crystallites, forming the material is larger than the claimed one, it is impossible to get necessary homogeneity of the composition and structure of the material because of the admixture of the monoclinal phase and surface cracks of different directions. And it causes decrease of wear-durability.

Colouring of the material depends on chromoforous cation, selected from the group of transition or rare-earth elements (cobalt, titan, chrome, aluminium, vanadium, manganese, iron, nickel, neodymium, lantern, praseodymium, cerium, samarium, europium, gadolinium, erbium, thulium, ytterbium and lutetium). The amount of the chromoforous additives in the material is not more than 5 mol%. For example, 1.0 mol% of nickel oxide allows to get greenish colour, and 3.5 mol% of erbium oxide – pink.

Black colour of the material, quite convenient for production of surgical blades, is achieved when further annealing of the claimed material is carried out at temperature of 1650-1750°C for not less than 3 hours.

To effect the method of obtaining the claimed material the equipment, which diagrams are shown in fig. 2 and fig. 3, is used.

The construction consists of the container, formed by base (1), being a semicylinder with vertical lateral walls (2) with a height of 0.5-1 of the cylinder diameter and side walls (3), and container lid (4). Container base (1) with the vertical walls (2), side walls (3) and lid (4) are made of the set of cooling tubes and/or sections (1) fixed on the non-conductor base (5). The container is placed within quartz envelope (6) while the side walls are covered from outside with fluoroplastic plate (7). Base(1) and lid (4) are capable move on guides (8) along the container base relatively to each other. Around the quartz container envelope an inductor (9) of high-frequency (HF) generator is installed. The container is connected with mechanism (11), providing horizontal moving of the container relative to inductor (9). The container and the inductor are placed into hermetic case (12), which is connected through regulating valve (13) to vacuum pump (14). Cooling water is supplied to the tubes through system (15) in directions N and withdrawn in directions M.

Making the setting available to move the container in horizontal direction relatively to the inductor, and also cooling of the container from all the sides allow to grow polycrystalline material with the claimed structure and a volume of up to 1500 cmi.

The method is effected by the following way. The charge (16), consisting of ZrO_2 , stabilizing oxide, metal, which stabilizing oxide

contains, or metallic zirconium for promoting the initial melting and the appropriate metal oxide for keeping necessary molar ratio of zirconium dioxide and stabilizing oxide, is loaded to the base of the container. The charge is rammed and if it is necessary an additional amount of the charge is put to fill the container base (1) completely. The lid (4) is put on the container and the charge is melted in HF field, created with the help of the inductor (9) of the HF generator (10) with frequency of 5.28 MHz and oscillating power of 60 Kvt. The charge is melted at a speed of moving container relatively to the inductor (9) of not more than 100 mm per hour. There is melt (17) around of which garnisage (18) is formed.

As a result gas and volatile compounds are removed completely from the melt. It promotes an additional purification from many admixtures volatile at melting temperature (about 3000°C), which hold out in intercrystalline pores when using regular method.

The melt is homogenized by holding it in melting state not less than for 3 hours. Then in the case (12) the tension is relieved to not more than 200-300 mm mercury and crystallization of the substance is carried out by moving the container in return direction at a speed of 0.1-30 mm per hour. The speed of passing the melting zone should ensure homogeneity and monophase of the obtained material. As a rule it is in the known range of 0.1-10 mm per hour. After that external cooling is kept and the power of HF field is decreased, promoting lowering of temperature. At a speed of not more than 50°C per hour temperature is decreased to 1300-1400°C. If temperature is lower, the energy of HF field is not absorbed by crystals. Further cooling to room temperature goes at gradual increase of pressure in the container up to atmospheric for not less than 24 hours. Then the container is opened by moving the lid (4) on the guides (8). A polycrystalline plate with a thickness of not less than 50 mm and a surface, counting 50-70% of the melt square in the container grows on the container base surface.

As a stabilizing oxide there is loaded into the charge an oxide, selected from the group of oxides of yttrium, cerium, magnesium, calcium. Amount of the oxide is determined by necessity of obtaining stabilized tetragonal modification. For every oxide the amount is different. For example, for yttrium oxide the amount is 2-4 mol%, for cerium oxide it is 6-13 mol% and for magnesium oxide – 4-8 mol%.

The repeated melting of the material at a speed of not more than 100 mm per hour after cooling it to 1300-1400°C increases homogeneity and regulating of the claimed material structure.

To obtain a coloured metal colouring chromoforous cation of the metal, selected from the group of transition or rare-earth elements (cobalt, titan, chrome, aluminium, vanadium, manganese, iron, nickel, neodymium, lantan, praseodymium, cerium, samarium, europium, gadolinium, erbium,

thulium, ytterbium and lutetium), is put into the charge in an amount of up to 5mol%.

Further annealing of the obtained material at temperature of 600-1400°C or at temperature of 1100-2000°C and pressure lowered to 10^{-4} – 10^{-1} mm mercury for 1-20 hours leads to reduction of internal strains in the material, increasing its strength.

The claimed method ensures high homogeneity of the obtained material, stability of its phase composition and ensures the claimed structure of the material. Besides, the method ensures the claimed shape of a separate crystallite and increase of the crystallite strength at expense of decrease of its defectiveness. It increases its cutting ability and makes it possible to produce high sharp, wear-durable articles.

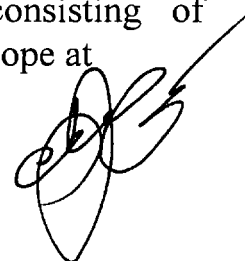
It is ascertained experimentally, when carrying out the method in conditions different from the claimed ones, it is impossible to get the claimed homogeneity and structure of the material, its monophase and absence of cracks.

The method is illustrated by the following examples.

Example 1.

To realize the method the setting, which diagram are shown on fig. 2 and fig.3 is used. The charge, consisting of 32.062 kg of ZrO_2 (97mol%) and 1.938 kg of Y_2O_3 (3mol%) is loaded on the base (1) of the container and rammed thoroughly. The container has length of 250 mm, vertical walls height of 90 mm and semicylinder diameter of 150 mm. 30 g of metallic zirconium is put into the charge, and 2 g of Y_2O_3 is added to save the molar ration. The lid (4) is put on the container, HF generator (10) is switched on, the initial melting is obtained, and then gradually all charge is melted by moving the container in horizontal direction relatively to the inductor at speed of 100 mm per hour. After the charge is melted, the melt is held for 8 hours. Then through the regulating valve (13) the vacuum pump (14) is connected up, discharging of 300 mm mercury is achieved, and the container is moved in return direction at speed of 1 mm per hour. There is the process of substance crystallization. Then by decreasing inductor power the container is cooled to 1300°C at speed of 50° per hour. The HF generator (10) is switched off and the pressure is increased gradually to room temperature for 24 hours. Then the container is opened. A crystalline plate with thickness of 55 mm and surface square of 260 cmI (1430 cmi) forms on the horizontal surface of the container base.

The plate represents a polycrystalline material, consisting of tetragonal crystallites of zirconium dioxide. Under the microscope at



1000-multiple magnification the cut confirms monophase and absence of defects of the obtained material (fig.1). Break strength, determined by method of chevron cut is 17 MPa/ml, and by method of ball pressing is 16 MPa/ml.

Comparative example 1.

The charge, which composition is analogous to the composition of the charge, described in example 1, is loaded into the container. Crystallization is carried out in conditions specified in example 1, but at standard pressuer. The material with heterogeneous composition and surface cracks is obtained (fig.4).

It should be noted that any infringement of the claimed conditions of obtaining material causes breach of material homogeneity and leads to the surface cracks.

Example 2.

For synthesis the charge, consisting of 29.64 kg (96.5 mol%) of ZrO_2 and 0.36 kg (3.5 mol%) of MgO is used. To promote the initial melting 30 g of metallic zirconium is put and to compensate metal oxide, formed during oxidation process, 5 g of MgO is added. Melting and crystallization process is carried out as it is described in example 1, with the exception, that after cooling the melt to temperature of 1400°C the repeated melting and crystallization are carried out at speed of 0.5 mm per hour.

A plate of partially stabilized polycrystalline monophase zirconium dioxide, having no defects, forms. This plate has break strength of 13 MPa/ml (determined by method of chevron cut) and 12 MPa/ml (by method of ball pressing).

The plates thickness is 50 mm, surface square is 260 cmI.

Example 3.

For synthesis the charge, containing 26.58 kg (90.0 mol%) of ZrO_2 and 2.95 kg (10.0 mol%) of CeO_2 is used. To promote the initial melting 30 g of metallic zirconium is put and to compensate metal oxide, formed during oxidation process, 4.5 g of CeO_2 is added. Melting and crystallization process is carried out as it is described in example 1, with the exception, that the initially formed melt is held for 5 hours before the process of crystallization. And after cooling the melt to temperature of 1300°C the repeated melting at speed of inductor moving of 100 mm per hour and crystallization at speed of 2.5 mm per hour are carried out.

A plate of partially stabilized polycrystalline monophase zirconium dioxide, having no defects, forms. Its thickness is 60 mm and surface square is 255 cmI. This plate has break strength of 16 MPa/ml (determined by method of chevron cut) and 15 MPa/ml (by method of ball pressing).

Example 4.

For synthesis the charge, containing 29.60 kg (87.5 mol%) of ZrO_2 , 3.40 kg (10.0 mol%) of CeO_2 and 0.85 kg (2.5 mol%) of Er_2O_3 is used. To

promote the initial melting 30g of metallic zirconium is put and to compensate metal oxide, formed during oxidation process, 4.5 g of CeO_2 is added. Melting and crystallization process is carried out as it is described in example 1.

A plate of partially stabilized polycrystalline monophase zirconium dioxide, having no defects, forms. Its thickness is 60 mm and surface square is 255 cm². This plate has break strength of 16 MPa/mI (determined by method of chevron cut) and 15 MPa/mI (by method of ball pressing). The plate has a pink colour.

Physical and mechanical characteristics of the claimed material allow to produce cutting edges of different instruments, for example medical scalpels of a necessary size for surgical operations, and also articles, used in conditions of increased loads.

Blades, produced of the claimed material have higher wear-durability and insure working resources up to 60 operations on dense tissues, such as skin, aponeurosis, paunch tissue. Higher durability of the claimed material to the beginning of cracking allows to resharpen the cutting edge of the blade up to 10 times without any changes of the blade profile.

Fig. 4-6 show the samples of medical scalpels, which blades are made of the claimed material. Fig. 7,8 show two types of blade sharpening.

For blades production the material is cut into plates with a thickness of (0.5-0.8) mm by a diamond detachable wheel, having a thickness of (0.2-0.3) mm. Then both sides of the plates are ground at several stages by diamond grinding wheels with a grain of abrasive – 20.0 μm at the first stage and (1.0-2.0) μm at the last stage. To get blade surface with a higher cleanness the wheels can be ground with diamond pastes with an abrasive of (0.5-1.0) μm .

Further on standard moulds half-finished products for blades of different types are cut out of a ground plate of an arbitrary shape with the help of a laser setting. Then the profile of the cutting edge of the blade is formed by a diamond sharpening instrument according to the field of use (shaving, complex with double angle of sharpening, with a slope on one side, etc.). the final stage of sharpening of the cutting edge of the blade is effected by a diamond sharpening instrument with a grain of 0.6 to 1.0 μm on the precision sharpening equipment. Control of sharpness of the blade cutting edge by a radioelectronic microscope showed that the diameter of rounding of the cutting edge was not more than 0.1 μm , and some separate samples had 0.05 μm .

The scalpel, shown on fig. 5-7 consists of the blade **A** with the cutting edge **B** and the blade holder **C**. The blade **A** with the cutting edge **B** are produced of the claimed material. The blade holder **C** is produced of steel. The blade **A** is attached to the holder **C** by gluing.

On fig. 8, 9 there are two types of sharpening of the blades, where **a** – thickness of the blade equal to (0.4-0.5) mm, **b** – diameter of rounding of the cutting edge of the blade equal to (0.05-0.1) μm , **ϕ** - angle of sharpening equal to $(25 \pm 1)^\circ$; **B** - angle of sharpening equal to $(40 \pm 1)^\circ$.

On fig. 10-13 there are photos of the articles – medical scalpels of different profiles with blades, produced of the claimed material.

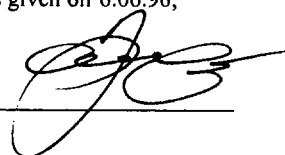
Production of the blades, made of the claimed material allows to increase working resources of the instruments.

So use of the proposed technical achievements allows to obtain the material based on tetragonal modification of partially stabilized zirconium dioxide by the claimed method. This material has higher resistance to the beginning of cracking, higher wear-durability and break strength. And it insures higher longevity and wear-durability of the products made of this material.

This translation from Russian into English was done by me,
Demidenko Elena Anatolievna, the certified translator, diplom of higher education
BBC № 0052236 given after the graduation from Far Eastern State
University, faculty of «Philology», qualification of philologist,
teacher of the English language and foreign literature. The diplom was given on 6.06.96,
registration number No. 1859.

The 2nd of April 2002

SIGNATURE



Claims

1. Polycrystalline material, consisting of crystallites of partially stabilized zirconium dioxide *is notable for*: the crystallites have a needle or plate shape, their height is not more than 0.05 mm, ration of the height to the maximum cross section is not less than 2:1, they arrange parallel to their long axes and form rectangular lattice.
2. Polycrystalline material as defined by claim 1, *is notable for*: as a stabilizing oxide it contains oxide of a metal, selected from the group of oxides of yttrium, cerium, magnesium, calcium.
3. Material as defined by claim 1, *is notable for*: in addition it contains oxide of a metal –chromofore, selected from the group of transition and/or rare-earth elements.
4. Material as defined by claims 1-3, *is notable for*: amount of oxide of metal-chromofore counts up to 5mol%.
5. Material as defined by claims 1,2, *is notable for*: it has black colour, obtained as a result of thermal treatment at temperature of 1650-1750°C for not less than 3 hours.
6. Method of producing material with structure as defined by claim 1, comprising loading of a charge, consisting of zirconium dioxide and stabilizing oxide, into the cooled container, melting of the charge, further crystallization by moving container relatively to the inductor at a speed of 0.1-30 mm per hour, cooling of the container to temperature of 1300-1400°C, *is notable for*: the process is carried out by moving container in horizontal direction relatively to the inductor, the melt is held for not less than 3 hours before crystallization process, crystallization and cooling of the container to temperature of 1300-1400°C are effected at pressure, lowered to 200-300 mm mercury, and cooling lower than 1400°C is effected by gradual increase of pressure for not less than 24 hours.
7. Method as defined by claim 6, *is notable for*: zirconium dioxide is used as a powder and/or crystalline waste products.
8. Method as defined by claim 6, *is notable for*: oxide of a metal, selected from the group of oxides of yttrium, cerium, magnesium, calcium, is added into the charge as a stabilizing oxide.
9. Method as defined by claim 6, *is notable for*: oxide of a metal-chromofore, selected from the group of transition and/or rare-earth elements, is added into the charge in amount of up to 5mol%.
10. Method as defined by claim 6, *is notable for*: after cooling container to temperature of 1300-1400°C, the repeated melting at a passing speed of not more than 100 mm per hour is carried out.
11. Method as defined by claim 6, *is notable for*: the formed material is subject to annealing at temperature of 600-1400°C and atmospheric

pressure or at temperature of 1100-2000°C and pressure lower than 10^{-1} mm mercury for 1-20 hours.

12. Blade based on partially stabilized zirconium dioxide *is notable for*: the material with the structure specified in claim 1, is used as the partially stabilized zirconium dioxide.

This translation from Russian into English was done by me,
Demidenko Elena Anatolievna, the certified translator, diplom of higher education
BBC № 0052236 given after the graduation from Far Eastern State
University, faculty of «Philology», qualification of philologist,
teacher of the English language and foreign literature. The diplom was given on 6.06.96,
registration number No. 1859.

The 2nd of April 2002

SIGNATURE

