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ALIEN PROPERTY CUSTODIAN

CERAMIC GOODS

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Ceramic goods are known which consist principally of alumina. Usually binding or fluxing agents are added as a flux to the alumina; however, it has also been used without any addition. The alumina is in this case preferably anhydrous and can be obtained according to known processes from bauxite.

The goods prepared in this way have, however, the disadvantage that on account of the high heat expansion of alumina, they are sensitive towards high rapidly altering temperatures.

According to the invention, ceramic goods stable towards high temperature changes are obtained by submitting pure anhydrous alumina to a second melting up process in an electric arc furnace at temperatures above 2000° C. By the second melting up, it is ensured that the purest anhydrous alumina with an Al_2O_3 content of 99.2% to 99.9% is probably freed from substances which appear to exert an unfavourable influence on the stability towards temperature change. Preferably for the manufacture of such a base material, precautions known in themselves are used if the best results are to be attained. The process is more fully described in the following:

The alumina only once melted, hitherto regarded as pure which is already used in this form for the manufacture of refractory goods, without any fluxes is once again completely melted up at temperatures above 2000° C in the electric furnace and then chilled. Thereby it is ensured first, that the subsequent comminution by breaking and grinding is made considerably easier. Thus it is possible to diminish the wearing of the grinding unit very considerably, and above all to avoid the contamination of the corundum which principally consists of finely divided iron particles, so far as it is technically possible. This is especially advantageous because it was known that the very finely divided iron powder reacts with the strongly hygroscopic ground corundum in such a manner that the absorbed water oxidises the metallic iron. These iron oxides are particularly disadvantageous because they cannot be completely removed either mechanically by a magnet or chemically, e. g. by acid treatment. It has now been found however, that they can be converted into such a form under the influence of agents giving off nascent hydrogen, that they are easy or easier to remove by the subsequent acid treatment.

Moreover, it has further been found that it is undesirable in certain conditions to remove wholly or in part, the metallic iron contained in the finely divided condition in the ground corundum, because this iron can be employed for hydrogen evolution, if use is not made of other agents, or together with these. From this point of view, the use of grinding units of soft iron is recommended in certain cases for the chilled mass, which was completely excluded hitherto, since they would give up too much iron to the ground corundum if the corundum is only once melted and not chilled.

It has been found that under certain conditions, a purer product can be obtained in the end from grinding units made of soft iron, than by the use of ground grinding units made of iron which is not so soft. The end product obtained after the acid treatment with or without intermediate heating in hydrogen has less than 0.05% iron.

The doubly melted corundum from which iron has been removed forms a valuable product, of which the ceramic qualities excel by far that of the hitherto used very pure alumina. Thus it has for example been found that in batches with zeolitic or permutitic fluxes it has as a consequence a considerably lower burning temperature than, e. g. the corresponding pure alumina and that the ceramic bodies produced are unexpectedly dense and hard. The ceramic goods are however above all specially resistant against abrupt temperature change irrespective of the fact that also a higher hitherto not obtainable mechanical solidity and especially good heat conductivity is obtained. The specially valuable properties of the doubly melted corundum being about naturally an economical use of the same in such proportions that on the one hand the object is attained and established, on the other hand, however, no waste of the raw material occurs.

It has further been found that it is possible to add up to 20% of very pure alumina to the doubly melted corundum, without the favourable properties being affected in any way. Such an addition can however, only be used without a diminution of the good properties if the proportion of the doubly melted corundum in the mass is not smaller than 65%.

It has been proposed with the hitherto known masses for ceramic bodies to use sintering media with a zeolitic or permutitic character. Such sintering substances can also be advantageously used with doubly melted corundum, as already mentioned.

It has however, further been found that these substances otherwise regarded as irreplaceable in the sintering of singly melted corundum can be replaced wholly or in part, without diminution of

the high stability to temperature change stability can be replaced either wholly or in part by a mixture of raw and burnt clay or kaolin together with alkaline earth oxides and a small proportion of silicic acid. This result is surprising and is probably to be explained by the fact that a corundum melted a second time at temperatures over 2000° C. appears to have become considerably more reactive.

The mixture of corundum and flux components, quite independently of the nature of the latter is preferably brought about in drum mills. It renders the uniform admixture more easiy if it is carried out dry. It has also been found that drum mills with highly elastic soft rubber casings in which the grinding bodies submit to mixing the mass burnt above 1500° C. are specially advantageous. By the rubber casing impurities in the mixture are excluded, independently of which the working life of the drum mills is considerably increased.

In the following are given two examples of carrying out the invention:

	Parts by weight
(1)	
Doubly melted corundum	75
Raw clay	Up to 11
Burnt clay	Up to 6
Very pure ground quartz	Up to 3
Alkaline earth oxide	Up to 5
Total mixture	100

Burning temperature under 1650° C.

	Parts by weight
(2)	
Doubly melted corundum	75
Raw clay	Up to 17
Very pure ground quartz	Up to 3
Alkaline earth oxide	Up to 5
Total weight	100

Burning temperature under 1650° C.

It is moreover already known to make short masses, e. g. those from sillimanite or aluminium oxide or common corundum so that they can be pressed in the moist state by giving them an addition of raw clay or kaolin of at least 20–30%.

With the masses according to the invention, is already obtained a good capacity for being pressed, and moulded even by an addition of less than 4% of raw kaolin, and a simultaneous water addition of at least 7.5% and at highest 10.5%. This is in fact chiefly to be attributed to the doubly melted corundum of which the ability to be pressed is increased as compared with singly melted corundum. Moreover, it must hereby be observed that the water addition small in itself, is evenly distributed in the mass itself, and the latter must be made as plastic as possible by fermenting in cooled spaces. It is likely that actually by this fermenting not only a sufficient wetting of the lean components such as the dusty ground corundum and the flux components, but also a thorough going uniformity of water distribution were obtained.

Such a mass can then also be pressed to give sufficiently solid bodies and even turned.

It is further also known to prepare bodies from short ceramic masses without fluxes by casting, mixtures with organic binding agents such as sulphite liquor, dextrin, agar-agar, gum arabic etc. to pug them, to harden them and to form them by turning. Moreover, a projection moulding process has been proposed which is specially economical for masses which consist of aluminium oxide, fused corundum, or preferably of fused corundum and a flux.

The masses forming the basis of the present invention which consist of doubly melted corundum can also in a manner known in itself be made capable of injection moulding by means of organic binding agents. They are then moulded by an injection process known in itself and burnt at temperatures under 1650° C. A pre-condition for injection moulding, however, is that they contain a proportion of raw clay or kaolin which lies under 10%. This is very advantageous since the injection moulded bodies become dense at lower burning temperatures than if they were prepared by wet moulding. Thus the content of raw clay or kaolin in the flux can be diminished to a considerable extent and if necessary the flux can be wholly or partly replaced by raw clay or kaolin.

In the hitherto known injection mouldable ceramic goods, their preparation is started from a predominant main component with which the so-called flux is mixed, whereupon the mixture is made capable of injection moulding in a known manner by admixture of organic binding agents.

It has been found that with the ceramic masses according to the invention, the main component and the flux can be melted together in an electric arc furnace without any further trouble. As previously, the melted product is then chilled and ground very finely. This ground mass can be made capable of injection moulding by addition of organic binding agents and the goods prepared therewith burnt at temperatures under 1650° C. to give dense products. In this manner it is ensured that the same components, which otherwise are first present in the hard burning of the ceramic goods, are already produced by melting in the electric arc furnace. It has been found that in the melt, molten corundum, aluminium silicate in the form of sillimanite or mullite and alkaline earth-aluminium-silicates are formed together and, on solidification, crystallise out. It is economically specially advantageous to operate in this manner, since a subsequent intimate mixing of doubly molten corundum and flux is no longer necessary. The new spraying process thus requires less consumption of time than the process hitherto used. It has moreover, been found that by the melting together of the corundum with the flux the proportion of the latter can be kept smaller although the goods thereby produced sinter below 1650° C. to dense products. This is apparently to be attributed to the fact that by the melting together the softening temperature or the sintering range of the mass is considerably lowered.

In the following a further example of carrying out the modification of the invention is given.

	Per cent by weight
Purest anhydrous alumina or corundum	75
Kaolin	Up to 17
Ground quartz	Up to 3
Alkaline earth oxide	Up to 5
	100

are all melted in an electric arc furnace, chilled and ground as finely as possible, preferably iron is removed according to the process already described, and the mass is made capable of injection moulding by means of organic binding

agents. Instead of raw or burnt slag and ground quartz can also be added, only ground quartz and alkaline earth oxide, and in fact in the same ratio as is necessary for the formation of corresponding amounts of aluminium silicate and alkaline earth-aluminium silicate in the molten liquid.

It has not been hitherto possible completely to burn and simultaneously to glaze the ceramic masses composed of corundum and flux in one burning. The strongly basic action of the material which consists predominantly of corundum which first strongly comes into question at burning temperatures of 1500–1650° C. makes any glazing impossible because even the material at this high temperature eagerly reacts with the acid components of the melted mass. It sucks the glaze up and thereby there is produced at its surface a rough matt covering layer and an intermediate layer. Both have however, different expansibilities than the ceramic body itself. By these different expansibilities strains are set up between the layers which may reach such an extent under certain conditions that by the occurrence of contraction, the relatively soft ceramic bodies may be destroyed in the finishing burn. It has been found that on the ceramic bodies according to the invention, by the use of a material which consists predominantly of felspar and which preferably is prepared so as to be capable of sprinkling, a glaze layer can be obtained at the finishing burn.

The bodies can be sprinkled with the blaze both in the raw as also in the incandescent condition, dipped or painted, or in any other known way provided therewith. The glaze or molten mass according to the invention reacts only little with the strongly basic bodies on account of its high proportion of alkali and forms a smooth and polished coating on the surface of the latter. It is however useless to provide by a suitable burning that the alkali content does not evaporate too far since when this exceeds a lower value the bodies then become useless on account of bubble formation on account of the destruction of the pot.

The felspar glaze can preferably be added to very finely ground alumina or molten corundum or a mixture of the two. Thereby the pure felspar glaze is stabilised and made specially heat stable. There is however obtained a certain equalisation of the shrinkage of the glaze to that of the pot. Preferably however, the proportion of these additions must singly or together not exceed 40%. Instead of such additions can however, also pure kaolin and/or pure quartz occur in the same proportions or proportions only slightly deviating therefrom.

Ceramic goods prepared according to the invention also have a high temperature change stability, with relatively good heat conductivity of approximately 0.01 (cal. cm.$^{-1}$.°C.$^{-1}$.sec.$^{-1}$) at 400° C.

There can thus be very advantageously manufactured from such masses, insulators for sparking plugs, for which as is known, amongst other properties, good heat conductivity is necessary.

It has been found that while maintaining high stability to temperature change, the heat conductivity of the products from corundum melted down together with the flux in the electric arc furnace, can be still further improved by keeping the proportion of flux between the limits 5–1.5% by weight with 95–98.5% by weight of very pure aluminium oxide. In this case it is, however, necessary that the melting down of the corundum with the proportion of flux, be brought about with small current output, for example with one phase current at a tension of 110 volts between electrodes, with at most 900 amp. It has been found that only under these conditions are molten cakes obtained which are capable of comminution afterwards. If however, it is melted with high current output, e. g. with 1,200–1,500 amps. at 110 volt electrode tension, then the product is so hard and dense that it can no longer or only with difficulty, be broken. After comminution and grinding of the molten product prepared according to the invention, the mass can be further worked up according to one of the known ways, and be burnt at 1750–1780° C.

The ceramic goods prepared according to this modification of the invention have a heat conductivity of 0.02–0.025 (cal. cm.$^{-1}$.°C.$^{-1}$.sec.$^{-1}$) at 400° C. with simultaneous higher stability to temperature change. The occurrence of these two properties increases the applicability of the ceramic mass according to the invention to insulators for spark plugs. It is generally known that in the hitherto used insulators in particular those of pure aluminium oxide or corundum the heat conductivity quickly falls with increase of heating. Over against this, the ceramic goods according to the invention, however, show a smaller falling off of heat conductivity with increase in temperature and almost equally high values at the temperature of use of about 550° C.

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