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CERAMIC TREATING PROCESS AND PRODUCT PRODUCED THEREBY

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ABSTRACT OF THE DISCLOSURE

A new ceramic treatment process and product and, more particularly, a process for treating underfired porous partially vitrified relatively soft machinable refractory ceramic materials to produce hardened dimensionally stable end products at relatively low temperatures and the ceramic materials produced thereby which are suitable for application as bearings for undersea submergence, low temperature bearings for arctic vehicular and machinery applications, precision bearings for space use and liquid metal lubricated systems. The soft ceramics can be machined and shaped in the soft state and hardened by the process of this invention at temperatures well below normal vitrification temperatures with virtually no change in dimensions from the machined untreated ceramic to the treated and hardened end product. Other products produced by the process of this invention produce articles having a very dense surface capable of taking a high polish and other products have resulted in an abrasive or polishing stone having superior qualities to those of the Arkansas stones in respect to both speed of metal removal and degree of polishing or sharpening. In addition, coarser or finer grades are obtainable compared to a single grade of Arkansas stone. Other products produced by this process have negative temperature coefficients becoming very good electrical and heat conductors at high temperatures.

This application is a continuation of application Ser. No. 642,704, filed June 1, 1967, now abandoned.

In accordance with the present invention, the process of treating underfired porous partially vitrified relatively soft refractory ceramic comprising the steps of shaping an underfired partially vitrified relatively soft refractory ceramic into a predetermined shape, impregnating the shaped ceramic with phosphoric acid and curing the impregnated ceramic at temperatures of at least 600° F., but below vitrification temperatures for a time sufficient to drive out the moisture and produce a hard ceramic.

Ceramic materials normally undergo substantial dimensional changes during the usual firing or vitrification steps. Thus, it has heretofore been extremely difficult to produce precision parts or intricate shapes from ceramics. Precision parts had to be shaped slightly oversize before firing. After firing the parts required further machining with diamond cutting wheels or by using lapping methods. Many intricate shapes were just not available since thin sections of parts would crack during firing.

In accordance with the present invention, it has been found that underfired or so-called machinable grade refractory ceramics can be shaped while in the relatively soft state and then impregnated and heat treated to produce a ceramic having all the characteristics of a vitrified ceramic without the usual change in dimensions. The process of the instant invention appears to be useful in the treatment of such refractory ceramic materials as the oxides of aluminum, beryllium, zirconium, titanium, magnesium and the like. These materials in the commercially available machinable grade are quite soft and easily

broken. Also, in the soft state, they can be readily cut with carbide cutting tools, drilled, filed, sanded and otherwise formed to practically any desired shape. One such aluminum and beryllium oxide material is available from Coors Ceramic Company of Golden, Colorado. When the machinable ceramics are treated by the method of this invention, they become very hard, approximating highly vitrified ceramic and, in addition, will retain the original machined and pre-treated dimensions. The treated material becomes so hard that the only practical method to do further machining is with diamond cutting wheels or by using lapping techniques.

The commercial value of the instant invention is readily seen when it is recognized that close tolerances on many intricate vitrified ceramic parts can only be obtained by machining with diamond cutting methods after firing. This is the case since there is considerable shrinkage which occurs during the firing. Also, there are many desired shapes which cannot be economically cast or molded during the firing process. In addition, it is often not feasible to construct molding dies for small quantities of a particular part. The method of the present invention in contrast thereto permits easy machining of parts to exact tolerances and then hardening the part without change in original dimensions.

It is, therefore, the principal object of this invention to provide an improved process for shaping, treating and hardening of machinable ceramics which avoids one or more of the disadvantages of prior art methods of producing close tolerance hardened shaped ceramic parts.

A further object of the present invention is to provide an improved process of producing hardened ceramic articles of manufacture of predetermined shapes, of predetermined characteristics and of predetermined dimensions.

Another object is to provide an improved method of producing close tolerance ceramic shapes of selected hardness, porosity and surface characteristics.

A still further object of the invention is to provide an improved process for the production of ceramic bearings capable of use with or without lubricants in hostile environments.

A further object of the invention is to provide an improved process for the production of an improved abrasive or polishing stone.

A further object of the invention is to provide a process for the production of a refactory ceramic oxide material having a negative temperature coefficient of electrical and heat conduction.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description, and its scope will be pointed out in the appended claims.

This invention is directed to a process and product involving a new type of ceramic material that is formed by chemically impregnating a relatively soft porous, underfired refractory oxide base material, followed by a low temperature cure. The resulting ceramic structure formed in this manner has been shown to exhibit extreme hardness, a high compressive strength and a dimensionally stable material over a wide temperature range. In addition, a number of these new ceramic materials show an inherently small coefficient of friction coupled with a very low wear rate characteristic.

Parts can be economically fabricated of this new material in a wide variety of intricate shapes and sizes. This is most easily accomplished by machining the relatively soft and porous refractory oxide base material to the final dimensions desired using conventional high speed steel or carbide tooling. The machined pieces are then chemically treated and cured at a temperature substantially below that used for normal ceramic vitrification.