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FORMATION OF EXPANDED SILICA SPHERES

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This invention relates to a method for manufacturing expanded silica spheroids of controlled density, to expanded silica spheroids so produced, to methods of producing microphone granules from such spheroids, and to such granules themselves.

At present in the art of telephony, roasted anthracite particles are widely used as the granular microphonic material in apparatus such as telephone transmitters. Earlier research has been done to find other substances which would be satisfactory replacements for such granules, and spheroids of refractory substances coated with thin conducting carbon films have been considered.

As a base material on which to deposit carbon, fused silica has shown itself useful. Fused silica is sufficiently refractory to withstand the high temperatures and reducing atmospheres necessary to deposit carbon films thereon. Most other glass or ceramic compositions become tacky, or melt down, or are unstable under the conditions required for carbon deposition.

Fused silica, further, has a low thermal expansion, and, consequently, a high thermal shock resistance. Such properties permit rapid heating and cooling during carbon deposition without danger of cracking. The carbon deposits laid on fused silica have a high adherence to the silica surface, also.

One disadvantage in the use of fused silica heretofore in the art was the limited density available in the resultant product. If the fused silica spheroids were made from rock quartz, or from crystalline or amorphous sands, the resultant fused product had an essentially invariant density of 2.2 grams per cubic centimeter. Much lighter fused silica spheroids can be produced by the method of C. J. Christensen, F. S. Goucher and H. G. Wehe, taught in Patent No. 2,151,083, issued to the inventors named on March 21, 1939. In the method there taught, silica gels, rather than the more conventional siliceous materials, are used as a source of silica. Water, associated with the silica in the gel, is vaporized by passing granules of the gel through the high-temperature flame of an atomic hydrogen torch. The vapor expands the silica, producing voids within the silica spheres formed in the high-temperature arc. The resultant spheres, with voids entrapped therein, have densities between approximately 0.5 gram per cubic centimeter and 0.7 gram per cubic centimeter.

Prior to the techniques of the present invention, the production of fused silica with densities intermediate to the extreme values found in the light material formed from silica gel and the heavy material formed from rock quartz or sands was unknown to the art. Yet, fused silica spheres of such intermediate density are perhaps most useful in the telephone art. The anthracite grains now in use in microphones have a density of 1.7 grams per cubic centimeter. Replacement of anthracite by another material, without necessitating extensive redesign of present equipment, would be easiest using a substitute of about the same density. Some slight adjustment of bulk density is usually made when regular spheroids are used to replace the irregular anthracite particles in transmitters because of differences in packing. The density of fused silica used as a substitute for the anthracite particles should preferably have an approximate density of 1.5 grams per cubic centimeter.

In the present invention, a new method of producing expanded silica has been devised. Using the method, silica spheroids of a density of about 1.5 grams per cubic centimeter, found useful in the telephone arts, can be produced consistently. The method can also be used, however, to produce expanded silica having any density intermediate to about 0.5 gram per cubic centimeter and 2.2 grams per cubic centimeter. Such silica bodies also have useful purposes other than as microphonic materials.

For example, expanded silica may be blended with lower-melting glasses into an inorganic insulating material of low dielectric constant. The dielectric constant of fused silica, about 4.0, is lowered by the inclusion of air, of a much lower dielectric constant, therein. Mixing of the air-infused silica particles with a binder or matrix of compatible glasses produces a rigid inorganic insulator with a favorable low dielectric constant. Such a mixture, shaped by casting, pressing, or extrusion, has many possible uses as a thermal shock-resistant insulating material in manufacturing radomes, dielectric lenses, or supports in electron tubes and other electrical equipment.

In the method of the invention herein disclosed, three forms of silica, fused quartz, silica gel, and colloidal silica, are mixed, dried, and screened to form irregular particles of the rough size desired. The screened material is fired at a controlled temperature to remove water loosely bound with the silica. Finally, by passing the fired granules through an atomic hydrogen arc, fusion sufficient to spheroidize the granules takes place. If the particles are to be used as microphone material, they can then be carbon coated. Other appropriate procedures, such as mixing and fusing with powdered glass, may be used if an insulating substance, or other products, are to be developed.

Density control of the finally-obtained expanded silica can be exercised at two stages of the process mentioned above. The density of the final material is perhaps most strongly affected by the choice of starting materials, and in particular, by the ratio of fused quartz to silica gel used in the forming mixture. Density control may also be exercised at the firing stage prior to spheroidizing in an atomic hydrogen arc. A stepwise consideration of the process, and discussion of the role played by the components of the forming mixture should illustrate the effect of each on the density of the product.

Fused quartz (fused silica, quartz glass, vitreous silica) is used as the high-density component in the forming mixture. The fused material, which is an amorphous, glassy variety of silica, can be prepared by fusion of crystalline forms of the same substance. Because of the allotropy of silica and the possible existence of two or more allotropes in silica heated to a high temperature, the melting point of quartz is uncertain. Solid bodies have been reported to begin softening at about 1100° C. However, considerably higher temperatures, depending on the speed of fusion desired, are probably required to accomplish complete fusion of silica, or of, at least, the stable low-temperature form, quartz. Such fused quartz, containing no appreciable chemically-bound water is, chemically, in a form similar to the silica eventually to be found in the resultant product. This similarity facilitates rapid fusion of mixtures in which the fused quartz is a major ingredient. Further, the excellent infra-red transmitting properties of fused quartz undoubtedly aid in bringing about the rapid fusion desired in the spheroidizing step. Either clear fused quartz or