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PROCESS FOR PRODUCING PIEZOELECTRIC TRANSDUCERS

Edwin P. Meiners and Glenn A. Schurman, Whittier, Calif., assignors to California Research Corporation, San Francisco, Calif., a corporation of Delaware

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This invention relates to a process for making piezoelectric transducers and to the transducers formed by the process, and particularly refers to ceramic blanks for transducers formed from solid finely-divided polycrystalline aggregates bonded together by a thermoplastic binder.

Heretofore transducers of this kind have been formed by mixing a suitable aggregate such as barium titanate with a small amount of glass-forming oxide, such as silica, with possible additions of alumina, magnesia or calcium oxide, the whole being brought to a sufficiently high temperature, for example 1300° C., to sinter the mass into a solid body which may be subsequently ground to any desired form. In certain cases thermosetting resins such as phenolformaldehyde have been proposed for a bonding agent. After sintering, the body may be polarized by applying a unidirectional electrical potential between electrodes formed on opposed faces of said body, while holding the body at a high temperature, to produce an electrical field of at least 25,000 volts per centimeter of thickness for a time sufficient to produce a substantial amount of piezoelectric effect in the body. Such procedures are described in U. S. Patent 2,538,554, issued January 16, 1951, to W. L. Cherry.

A disadvantage of the prior method of producing ceramic transducers of this kind was the necessity of several separate operations, first pressing the powdered aggregate to approximate shape, then heating it twice, first at high temperature to sinter the binding material and then at a lower temperature while polarizing, after which the unit was finally ground to exact dimensions. Also, it has been found that the mode of distribution of the binder for the aggregate is relatively critical both as to the homogeneity and mechanical strength of the finished unit and also as to its electrical properties. It has been found, for example, that a mixture of finely divided dry binder material with the ceramic aggregate particles will not produce as desirable a structure, presumably due to clumping of the components, during heating and forming, which adversely affects the final unit.

It is an object of this invention to provide an improved procedure for producing a piezoelectric transducer that involves fewer operations and results in a product having desirable properties as compared to those heretofore available.

Another object is to provide an improved procedure for preparing the ceramic aggregate prior to the pressing into the final form and dimensions of the transducer unit, as well as simplification of such pressing and molding procedures.

These and other objects and advantages of this invention will be further apparent from the following description of a preferred procedure for preparing ceramic transducer units.

A preferred aggregate of barium titanate or barium strontium titanate in finely divided form, for example

350 mesh, is combined with about 5 to 10 percent by weight of binder, such as the thermoplastic methyl methacrylate polymer known as "Lucite," which has previously been dissolved in an excess of solvent such as ethyl acetate in a ratio of 1 gram of solid polymer to about 10 cc. of ethyl acetate. After thorough agitation to insure adequate wetting of all of the finely divided aggregate particles, the solvent is evaporated, also with agitation, to leave each particle coated with a thin and tightly adherent layer of the solid thermoplastic binding agent. The dry coated particles are redivided, for example by being again ground to about 300 mesh, after which they can be formed into any desired and final shape by injection or other molding procedures at a relatively low temperature, such as 150° C. After such forming is complete, the unit may be polarized to develop its piezoelectric properties, for example by applying a direct current potential between metallic electrodes suitably secured or formed upon opposed faces to produce a field of about 25,000 volts per cm. thickness for a period of at least 1 hour and at room temperature, or at any suitable temperature below the softening point of the thermoplastic binder.

A particular advantage of the intially coated ceramic aggregate particles produced and utilized by this process is their ease of handling in the final molding step, as they flow readily in the moderately heated mold and can thus be injection molded to exceedingly close dimensional tolerances and in large sizes at moderate forces.

A further advantage of the final transducer element or unit formed by this process is its superior resistance to moisture, its smooth and glassy outer surface, and particularly its desirable internal damping characteristics.

Although only a single example has been given of the process and the product resulting therefrom, it is apparent that changes, both in the aggregate material and in the dielectric thermoplastic binder, as well as in the proportions of each, could be made without departing from the invention, which appears to reside in the precoating of the finely divided aggregate particles with the binder in solid form, followed by redivision and final molding to finished dimensions. Accordingly, all such changes that come within the scope of the appended claims are intended to be embraced thereby.

We claim:

1. In the manufacture of piezoelectric transducer units from a solid polycrystalline aggregate of mineral crystals and a thermoplastic binder, the steps of coating particles of said aggregate with a solution of said binder, evaporating the solvent from said particles to leave a solid coating of binder on said particles, redividing said coated particles, and molding said particles to the final form of said transducer unit.

2. In the material according to claim 1, the added step of electrically polarizing the final form of said transducer unit at a temperature below the softening temperature of said binder.

3. In the method according to claim 1, the added steps of securing electrodes to opposite faces of said transducer and applying a polarizing potential between said electrodes to produce a permanent piezoelectric effect in said unit.

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