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SINGLE CRYSTAL BARIUM TITANATE

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4 Claims. (Cl. 23—301)

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment of any royalty thereon.

This invention relates to an improved method of making and treating single crystals of barium titanate.

Barium titanate is a well known ferroelectric material having unusual electrical characteristics, and, as a single crystal, is particularly well suited for use in computers, magnetic amplifiers and memory devices. It is most desirable to produce single crystal barium titanate of usable size for such devices. Many attempts have been made in the past to grow usable size single crystals of barium titanate, however the resultant single crystals produced by these prior techniques were so small in size that they could not be employed for many actual uses. Heretofore, efforts for growing large single crystals of barium titanate have not been successful.

It is accordingly an object of the present invention to provide a satisfactory method for producing single crystals of barium titanate of commercially usable size. This and other objects will become more apparent from the following more complete description of a practical embodiment of the invention.

To start the growing process, a single crystal, or seed crystal, of barium titanate is completely incased in a shell of barium titanate powder of uniform small particle size to form a pellet having a thickness of about one-quarter of an inch. This pellet is formed by first embedding the single crystal in the barium titanate powder and then subjecting the completely embedded single crystal at room temperature, in a conventional cold pressing technique, to pressures of about 10,000 p.s.i.

It should be noted that a great measure of success is achieved if the starting material of barium titanate powder, which forms the matrix from which the single crystal of this invention is grown, is of uniform particle size. The particle size should not exceed about 0.5 micron, and may be as small as 0.02 micron. Such a material may be conveniently prepared by a method disclosed by the applicants in patent application Serial Number 701,277 filed on December 6, 1957, now U.S. Patent No. 2,985,506.

Small single crystals of barium titanate, heretofore produced, grow in one of two different crystal habits, the crystals growing either as thin plates or as chunky rectangular crystals. The single crystal preferred for use in the above step are of the thin plate type and have a thickness of about one millimeter. Best results have been obtained with barium titanate single crystals made in accordance with a method described by J. P. Remeika in the Journal of the American Chemical Society, 1954, vol. 76, pages 940, 941.

The cold formed pellet is next hot pressed in a non-reducing atmosphere, under a pressure of about 5000 p.s.i. and at a temperature of about 1000 to 1200° C. The hot pressed pellet thus formed is maintained at this temperature and pressure for a period of about 10 to 20 minutes.

The hot pressed pellet is now subjected to further heat

treatment, by convenient means, at a temperature of about 1250° C. up to about 1600° C., but preferably around 1350° C. for about 72 hours. During this subsequent heating step, the barium titanate seed crystal grows in size at the expense of the barium titanate matrix powder. In any event, such heat treatment should not be carried out at temperatures greater than 1600° C., which is in the neighborhood of the melting point of barium titanate. The pellet is then slowly cooled to room temperatures to prevent strains and fractures. The single crystal is now cut and polished to form various ferroelectric elements.

By the method described above, a single crystal of barium titanate has been prepared having a thickness of about three millimeters. This resultant crystal has a thickness about three times that of the original starting seed crystal, and is of commercially usable size, suitable for use in various electronic devices.

This invention provides a rapid process for the manufacture of single crystal barium titanate which is economical and easy to operate. It should be noted that the basic process disclosed is adaptable to many materials such as ferrites, titanates, silicates and other sinterable materials.

While there has been described what is at present considered to be the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. The method of producing a single crystal body of barium titanate having a thickness of about three millimeters comprising the steps of embedding a seed crystal of barium titanate having a thickness of about one millimeter in barium titanate powder, subjecting said completely embedded seed crystal at room temperatures to pressures of about 10,000 p.s.i. to form a pellet, said barium titanate powder having a uniform particle size not exceeding about 0.5 microns, hot pressing the formed pellet at a temperature of about 1000 to 1200° C. under a pressure of about 5000 p.s.i., and subsequently subjecting the hot pressed pellet to a temperature of about 1250° C. up to about 1600° C. for about 72 hours.

2. The method of claim 1 wherein said subsequent heat treatment of said hot pressed pellet is about 1350° C.

3. The method of claim 1 wherein said barium titanate powder has a uniform particle size of about 0.02 micron.

4. The method of claim 1 wherein said hot pressing is maintained for a period of about 10 to 20 minutes.

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