

CAPACITANCE DISCHARGE METHOD FOR SOLID STATE ACTUATOR

FIELD OF THE INVENTION:

The field of invention is related to the Piezo ceramic, which does not result hysteresis when the electric potential is reversed. The presence of hysteresis causes lots of problems in case of Nanopositioning applications, such as errors in positioning, repeatability, creep etc. However, the hysteresis also results in many problems in various applications. Hence using nanostructured raw materials for solid-state actuator is expected to minimize the hysteresis effects.

BACKGROUND OF THE INVENTION:

Solid-state actuators are the heart for Nanopositioning and various other applications in controlling the functions precisely. The application of electric potential on solid-state actuators causes a change in physical size, known as piezo and inverse Piezo effect. When the electric potential is removed or reduced, the change in physical size or contraction in the actuators does not follow the same track as when it expanded. This effect is known as hysteresis. This is due the charge present in the actuators even when the electric potential is reduced. There are some approaches in design of electronics drive in which charge current is fed in place of electric voltage. However, this is a complex design process on which still research is going on. On contrary to the electronics approach, manipulating the materials characteristics of the actuators in order to discharge the capacitance is another novel method.

This invention is still in the research stage

The paper titled "Piezoresponse of NB-Doped PZT Ceramic and its Application" by Bing Huei Chen and Long Wu, discusses about their investigation of nano lead zirconate titanate piezo ceramics.

Advantages: By using Nanostructured raw materials for the manufacture of the solid state actuators, the grain size is reduced and hence the discharge becomes easier. Also, the use of complicated electronics drive system is minimized.

Disadvantage: Production is nanostructured powder is still under research level.

OBJECTIVES OF THE INVENTION:

The primary objective of the present invention is to develop a method of capacitance discharge for solid state actuators.

Still other objective of the present invention is to develop Piezo material for solid state actuators with no or minimal amount of hysteresis.

Still another objective of the present invention is to use Nanostructured raw materials for making the solid-state crystal.

STATEMENT OF THE INVENTION:

A method of capacitance discharge for solid state actuators, wherein the said method uses Nanostructured Piezo material with no or minimal amount of hysteresis and will be useful in precision applications and nanotechnology etc. Nanostructured raw materials like Nano powders of lead Zirconate titanate are used for making Piezo material such that the capacitance can be easily discharged.

DETAILED DESCRIPTION OF THE INVENTION:

Accordingly the present invention relates to a method of capacitance discharge for solid state actuators, wherein said method comprises using Nanostructured Piezo raw material with no or minimal amount of hysteresis.

Yet another embodiment of the present invention, wherein the method as claimed in claim 1, wherein the nanostructured raw materials are Nano powders of lead Zirconate titanate.

Still another embodiment of the present invention, wherein the Nano powders are mixed, calcined, then mixed with an organic binder, pressed or moulded into structural elements and the green ceramic shapes are fired, heated and sintered.

Yet another embodiment of the present invention, wherein the ceramic block so obtained is then cut, polished, lapped and subjected to poling.

Still another embodiment of the present invention, wherein the method for preparing multilayer piezo actuator comprises ball milling the raw material, preparing the slurry of the ball milled material, foil casting the slurry to obtain sheet, screen-printing the sheet and laminating the printed sheets.

Yet another embodiment of the present invention, wherein increasing the laminated density of the green ceramics by compacting that removes air trapped between the layers, followed burning the binders, sintering at temperature below 1100°C, end-termination and poling the same.

Still another embodiment of the present invention, wherein the process, especially the heating and sintering cycles, must be controlled to very tight tolerances.

Yet another embodiment of the present invention, wherein the method is useful in technologies selected from a group comprising precision applications and nanotechnology.

Nanostructured raw materials are used as for making Piezo material in which the grains size is so small that the capacitance can be easily discharged.

The defining equations are:

$$1. C = \epsilon A / t$$

Where, C = Capacitance

A = Capacitor plate area

t = thickness or plate separation

ϵ = Dielectric constant

and,

$$2. Q = C * V$$

Where, Q = Charge

V = Voltage applied

Now, the theory behind using Nano lead zirconate titanate during the manufacture of piezo ceramic actuators is to reduce A (Capacitor Plate Area). It can be seen from Equation 1 that when A reduces C (Capacitance) also decreases. Thus, what can be done is during the process of manufacturing piezo ceramics actuators using nano lead zirconate titanate, we have to make sure that while A decreases, t is either kept constant or increased. This can be achieved by controlling the number of grains and the grain size, which plays a major role in the dimension of A and t.

To prepare piezo electric ceramic, Nano powders of lead zirconate titanate is used as raw materials in appropriate ratios that are mixed well. This mixture is then heated (calcined) to form a uniform powder. The powder is mixed with an organic binder and is pressed or molded into structural elements having the desired shape. The 'green' ceramic shapes are fired according to a specific time and temperature program, during which the powder particles sinter and the material attains a dense crystalline structure. The ceramic is then heated to 750° C to burn out the binder. The sintering process at 1250° C to 1350° C is the next phase.

The ceramic block is then cut, ground, polished, and lapped to the desired shape and tolerance. Electrodes are applied by sputtering or screen-printing technique. Finally,

the ceramic is placed in the heated oil bath at electrical fields up to several kV / mm. This process is called poling.

The process for multilayer piezo actuator is slightly different from the earlier one. After ball milling the raw materials, slurry is prepared. By foil casting process, layer thickness down to 20 μm is formed. Then the sheets are screen-printed and laminated. The density of the green ceramics is increased by compacting process that removes air trapped between the layers. Finally, the binders are burnt, sintering (co-firing) at temperature below 1100°C, end termination and poling. The process, especially the heating and sintering cycles, must be controlled to very tight tolerances. The smallest change affects quality and properties of the Piezo material.

Advantages of the Invention

- Material properties of the piezo ceramic actuators is itself manipulated to reduce hysteresis
- Reduces the need of expensive feedback systems or complex electronics systems

Applications of the invention

Positioning

- Laser
- Optics
- Microscopes
- Micromanipulation
- Data processing
- Printers
- Data storage
- Medical
- Micro pumps
- Dosing
- Surgery instruments
- Consumer
- Cameras
- Video
- Active Noise and Vibration

Control (ANVC)

- Mechanical structures
- Automotive
- Aerospace
- Piezoelectric motors
- Positioning
- Automotive
- Aerospace

We Claim:

1. A method of capacitance discharge for solid state actuators, wherein said method comprises using Nanostructured Piezo raw material with no or minimal amount of hysteresis.
2. The method as claimed in claim 1, wherein the nanostructured raw materials are Nano powders of lead Zirconate titanate.
3. The method as claimed in claim 2, wherein the Nano powders are mixed, calcined, then mixed with an organic binder, pressed or moulded into structural elements and the green ceramic shapes are fired, heated and sintered.
4. The method as claimed in claim 3, wherein the ceramic block so obtained is then cut, polished, lapped and subjected to poling.
5. The method as claimed in claim 1, wherein the method for preparing multilayer piezo actuator comprises ball milling the raw material, preparing the slurry of the ball milled material, foil casting the slurry to obtain sheet, screen-printing the sheet and laminating the printed sheets.
6. The method as claimed in claim 5, wherein increasing the laminated density of the green ceramics by compacting that removes air trapped between the layers, followed burning the binders, sintering at temperature below 1100°C, end-termination and poling the same.
7. The method as claimed in claim 5, wherein the process, especially the heating and sintering cycles, must be controlled to very tight tolerances.
8. The method as claimed in claim 1, wherein the method is useful in technologies selected from a group comprising precision applications and nanotechnology.