

CLAIMS

What is claimed is:

1. A multi-layer piezoelectric element, comprising:
a stacked body in which piezoelectric layers and internal electrode layers are alternately laminated and a stress relaxing layer is disposed at part of portions between the piezoelectric layers; and
an external electrode configured to bond to a side face of the stacked body so as to make electrical connection with the internal electrode layers,
wherein the internal electrode layers are not exposed on the side face except for a region bonded to the external electrode, but the stress relaxing layer exposes on the side face of the stacked body.
2. The multi-layer piezoelectric element according to claim 1, wherein the stress relaxing layer contains more voids than the internal electrode layers.
3. The multi-layer piezoelectric element according to claim 1, wherein the stress relaxing layer includes metal portions that are independent of each other.

4. The multi-layer piezoelectric element according to claim 1, wherein a plurality of stress relaxing layers are arranged at a predetermined interval in a stacked direction of the stacked body.

5. The multi-layer piezoelectric element according to claim 1, wherein the external electrode has a slit formed in a portion of the external electrode corresponding to a location of the stress relaxing layer between the piezoelectric layers.

6. The multi-layer piezoelectric element according to claim 1, wherein a non-formed region where the stress relaxing layer is not formed exists between the piezoelectric layers.

7. The multi-layer piezoelectric element according to claim 6, wherein the stress relaxing layer is divided by the non-formed region between the piezoelectric layers.

8. The multi-layer piezoelectric element according to claim 1, wherein an outer lead member is bonded via a conductive bonding member to a surface of the external electrode.

9. An injection device, comprising:
a container comprising an injection hole; and
the multi-layer piezoelectric element according to
claim 1, wherein
a fluid stored in the container is configured to be
injected through the injection hole by driving operation
of the multi-layer piezoelectric element.

10. A fuel injection system, comprising:
a common rail configured to store a high-pressure
fuel;
the injection device according to claim 9,
configured to inject the high-pressure fuel stored in the
common rail;
a pressure pump configured to supply the high-
pressure fuel to the common rail; and
an injection control unit configured to send a drive
signal to the injection device.

11. A method for manufacturing a multi-layer
piezoelectric element, comprising the steps of:
applying a first conductive paste for forming an
internal electrode layer onto a center region of a main
face of a first piezoelectric ceramic green sheet for
forming a piezoelectric layer, and applying a second

conductive paste for forming a dummy internal electrode layer onto a peripheral region of the main face of the first piezoelectric ceramic green sheet so as to surround the first conductive paste at a predetermined interval therefrom;

applying a third conductive paste for forming a stress relaxing layer onto an entire main face of a second piezoelectric ceramic green sheet for forming a piezoelectric layer;

forming a stacked compact by laminating the first and second piezoelectric ceramic green sheet in a predetermined number;

forming a stacked body in which piezoelectric layers and internal electrode layers each surrounded by the dummy internal electrode layer are alternately laminated and the stress relaxing layer is disposed at part of portions between the piezoelectric layers, by firing the stacked compact; and

removing the dummy internal electrode layer together with a peripheral region of the piezoelectric layer, by grinding the side face of the stacked body.