CLAIMS

1. A wireless piezoelectric accelerometer, comprising:

a piezoelectric sensing element configured to sense mechanical acceleration and produce an electrical charge signal in response of the sensed mechanical acceleration;

a signal processing module (SPM) configured to convert the electrical charge signal into a voltage signal, and process and digitize the voltage signal; and

a wireless module configured to modulate and transmit the digitized voltage signal as wireless signals,

wherein the piezoelectric sensing element, the SPM and the wireless module are packaged in a casing, and

wherein the casing comprises a metallic shielding chamber configured to enclose the piezoelectric sensing element; and wherein the casing further comprises a non-metallic portion located in relation to the wireless module so as to allow transmission of the wireless signals, and

wherein the casing comprises a metallic base including the metallic shielding chamber, the metallic base comprising a metallic bottom and a metallic wall wrapping around the metallic bottom, and

wherein a post is formed in the metallic bottom protruding inwardly in a direction perpendicular to a main surface of the metallic bottom to form a mounting portion of the metallic bottom for mounting the wireless piezoelectric accelerometer.

2. The wireless piezoelectric accelerometer in accordance with claim 1, wherein the non-metallic portion comprises plastic, and wherein the non-metallic portion and the metallic base are engageable so the wireless piezoelectric accelerometer is enclosed.

3. The wireless piezoelectric accelerometer in accordance with any preceding claim, wherein the piezoelectric sensing element is a miniaturized piezoelectric micro electromechanical system (MEMS) bending-mode sensor immobilized on the metallic bottom for bending-mode sensing to detect acceleration in a direction perpendicular to a main surface plane of the metallic bottom.

4. The wireless piezoelectric accelerometer in accordance with either claim 1 or claim 2, wherein the piezoelectric sensing element is a piezoelectric shear-mode sensor mounted on a surface of the post perpendicular to a main surface of the metallic bottom and within the metallic shielding chamber for shear-mode sensing to detect acceleration in a direction perpendicular to the main surface of the metallic bottom.

5. The wireless piezoelectric accelerometer in accordance with any preceding claim, wherein the SPM comprises a primary SPM and a secondary SPM,

wherein the primary SPM comprises an amplifier circuit,

wherein the secondary SPM comprises an analog to digital converter (ADC) and a microcontroller (MCU), wherein the MCU is programmable to control the wireless piezoelectric accelerometer, and wherein the primary SPM is enclosed in the shielding chamber.

6. The wireless piezoelectric accelerometer in accordance with claim 2, further comprises a power supply module, wherein the wireless module and the power supply module are mounted on a print circuit board (PCB) which is immobilized within the metallic base.

7. The wireless piezoelectric accelerometer in accordance with claim 6, wherein the metallic base comprises one or more groove and ridge structures on the inner brim of the metallic wall, and wherein the PCB is interlocked in the groove structure between the ridge structures.

8. The wireless piezoelectric accelerometer in accordance with claim 6, wherein a metal plate is provided within the metallic base and located between the PCB and the metallic bottom so that the metal plate and portions of the metallic bottom and the metallic wall form the shielding chamber.

9. The wireless piezoelectric accelerometer in accordance with claim 6, wherein the shielding chamber is placed within the metallic base in a space formed between the PCB and the metallic bottom.

10. The wireless piezoelectric accelerometer in accordance with claim 6, wherein the power supply module comprises a power supply circuit and one or more batteries, wherein the power supply circuit is mounted with the wireless module on an upper side of the PCB under the plastic lid, whereas the one or more batteries are mounted on a lower side of the PCB.

11. The wireless piezoelectric accelerometer in accordance with claim 6, wherein the power supply module comprises a power supply circuit and one or more batteries, wherein the power supply circuit and the one or more batteries are mounted with the wireless module on an upper side of the PCB.

12. The wireless piezoelectric accelerometer in accordance with claim 2, wherein the metallic base is treated to comprise an insulation layer on its inner and external surfaces.

13. The wireless piezoelectric accelerometer in accordance with claim 2, wherein the shielding chamber is electrically grounded through an inner surface of the metallic base.

14. The wireless piezoelectric accelerometer in accordance with claim 2, wherein the non-metallic portion is a plastic lid.

15. The wireless piezoelectric accelerometer in accordance with claim 1, wherein the casing has an overall height and a lateral width, and wherein the overall height is smaller than the lateral width.

16. The wireless piezoelectric accelerometer in accordance with claim 3, wherein the MEMS bending-mode sensor comprises a plurality of micro-machined silicon beams, wherein a piezoelectric thin film is coated on the plurality of micro-machined silicon beams.

17. The wireless piezoelectric accelerometer in accordance with claim 16, wherein the plurality of silicon beams comprise a plurality of interdigital electrodes (IDTs) configured to provide an in-plane polarization in the piezoelectric thin film.

18. The wireless piezoelectric accelerometer in accordance with claim 16, wherein the MEMS bending-mode sensor is immobilized onto the metallic bottom, wherein the plurality of micro-machined silicon beams are aligned in parallel with a main surface plane of the metallic bottom, such that the wireless piezoelectric accelerometer is configured to detect an acceleration in the direction perpendicular to the main surface plane of the metallic bottom.

19. The wireless piezoelectric accelerometer in accordance with claim 18, wherein the MEMS bending-mode sensor and the amplifier circuit are fabricated on a same silicon wafer.

20. The wireless piezoelectric accelerometer in accordance with claim 18, wherein the MEMS bending-mode sensor and the amplifier circuit are fabricated on different silicon wafers and joined together through a bonding process.

21. The wireless piezoelectric accelerometer in accordance with claim 4, wherein the piezoelectric shear-mode sensor comprises a piezoelectric single crystal plate, wherein the piezoelectric shear-mode sensor is configured to convert a shear strain of the piezoelectric single crystal plate induced by an acceleration to an electric charge signal.

22. The wireless piezoelectric accelerometer in accordance with claim 21, wherein the piezoelectric single crystal plate is a piezoelectric lead magnesium niobate-lead titanate (PMN-PT) single crystal plate or a piezoelectric lead zinc niobate-lead titanate (PZN-PT) single crystal plate with a perovskite crystal structure, wherein a polarization direction of the piezoelectric single crystal plate is aligned with an axis direction of the post, such that the wireless piezoelectric accelerometer is configured to detect the acceleration in a direction parallel with the inside surface of the post.

23. A wireless piezoelectric accelerometer system, comprising:

a wireless piezoelectric accelerometer comprising:

a piezoelectric sensing element configured to sense mechanical acceleration and produce an electrical charge signal in response of the sensed mechanical acceleration;

a signal processing module (SPM) configured to convert the electrical charge signal into a voltage signal, and process and digitize the voltage signal; and

a wireless module configured to modulate and transmit the digitized voltage signal as wireless signals,

wherein the piezoelectric sensing element, the SPM and the wireless module are packaged in a casing, and wherein the casing comprises a metallic shielding chamber configured to enclose the piezoelectric sensing element; and wherein the casing further comprises a non-metallic portion located in relative to the wireless module to allow transmission of the wireless signals, and wherein the casing comprises a metallic base including the metallic shielding chamber, the metallic base comprising a metallic bottom and a metallic wall wrapping around the metallic bottom, and wherein a post is formed in the metallic bottom protruding inwardly in a direction perpendicular to a main surface of the metallic bottom to form a mounting portion of the metallic bottom for mounting the wireless piezoelectric accelerometer;

a base unit; and

a signal analyzing device,

wherein the wireless piezoelectric accelerometer and the base unit are connected via a wireless link, and wherein the base unit and the signal analyzing device are connected via an interface.

24. The wireless piezoelectric accelerometer system in accordance with claim 23, wherein the interface comprises an universal serial bus (USB).

25. The wireless piezoelectric accelerometer system in accordance with claim 23, wherein the base unit is configured to control the wireless piezoelectric accelerometer to operate in a sleep mode and a wake mode.

26. The wireless piezoelectric accelerometer system in accordance with claim 23, further comprising one or more repeater units between the wireless piezoelectric accelerometer and the base unit so as to extend a communication range between the wireless piezoelectric accelerometer and the base unit.