Claims

1. A high-Q multi-mode dielectric resonant structure, comprising a cavity, a dielectric support frame, a dielectric resonator and a cover plate; the cavity is formed by a sealed space, wherein one surface of the cavity is a cover plate surface; the dielectric resonator is formed by a dielectric material; the dielectric resonator is mounted in the cavity without contacting an inner wall of the cavity; the dielectric support frame is mounted in any positions between the dielectric resonator and the inner wall of the cavity, matched with any shapes of the dielectric resonator and the cavity and fixed by connecting, wherein the dielectric resonator comprises an integrated dielectric resonator or a split dielectric resonator formed by a plurality of small dielectric resonant blocks and formed by splicing dielectric or metal connecting blocks,

the cavity is internally provided with the dielectric resonators formed by two single axial vertically intersected cylinders or polygons and the fixed dielectric support frame thereof to form a high-Q multi-mode dielectric resonant structure with the cavity, wherein the X-axis dimension of the cylindrical or polygonal on a X-axial direction in the dielectric resonator is greater than or equal to the perpendicular dimension, parallel to a X-axis, of the cylindrical or polygonal dielectric resonator with a Y-axis; and wherein the Y-axis dimension of the cylindrical or polygonal on a Y-axis direction in the dielectric resonator is greater than or equal to the perpendicular dimension, parallel to the Y-axis, of the cylindrical or polygonal dielectric resonator with the X-axis; or

the cavity is internally provided with the dielectric resonators formed by three single axial mutually vertically intersected cylinders or polygons and the fixed dielectric support frame thereof to form a high-Q multi-mode dielectric resonant structure with the cavity, wherein the X-axis dimension of the cylindrical or polygonal on the X-axis direction in the dielectric resonator is greater than or equal to the perpendicular dimensions, parallel to the X-axis, of the cylindrical or polygonal dielectric resonator with the Y-axis and the cylindrical or polygonal with the Z-axis in the dielectric resonator; wherein the Y-axis dimension of the cylindrical or polygonal on the Y-axis direction in the dielectric resonator is greater than or equal to the perpendicular dimensions, parallel to the Y-axis, of the cylindrical or polygonal with the X-axis and the cylindrical or polygonal with the Z-axis; and wherein the Z-axis dimension of the cylindrical or polygonal on a Z-axis direction in the dielectric resonator is greater than or equal to the perpendicular dimensions, parallel to the Z-axis, of the cylindrical or polygonal with

the X-axis and the cylindrical or polygonal with the Y-axis,

the high-Q multi-mode dielectric resonant structure , wherein when a ratio of the size of the inner wall of the cavity to the size corresponding to three axial directions of any one of the dielectric resonators or a ratio of the sizes in horizontal and vertical directions is between 1.01-4.5, when the cavity size and the fundamental mode frequency are maintained unchanged, two dielectric resonators which are formed by perpendicularly intersecting single axial cylinders or multilateral bodies, or three dielectric resonators which are formed by perpendicularly intersecting single axial cylinders or multilateral bodies with each other, a high Q multi-mode dielectric resonant structure is formed with a dielectric support frame fixed thereto and a cavity, and the high Q multi-mode dielectric resonant structure forms 2-6 basic modes with the same frequency or close to the same frequency, a plurality of high order modes with different frequencies form 1-N high order modes with the same frequency, wherein N is a natural number greater than 1, When the ratios of the three axial dimensions corresponding to the dielectric resonator to the dimensions of the cavity corresponding to the dielectric resonator change, the fundamental mode and the multi-modulus data volume corresponding to the dielectric resonator also change correspondingly;

while the high-Q multi-mode dielectric resonant structure is used for trimming, slotting and corner cutting of adjacent coupling and cross coupling to form filter in the horizontal and vertical directions , while the dimension of the inner wall of the cavity thereof and the three axial dimensions corresponding to the dielectric resonator are changed or the dimensions in the horizontal and vertical directions are changed, so as to change the frequency of a fundamental mode and the frequencies of a plurality of high-order modes and change the Q value corresponding to the fundamental mode,

while the frequency of the fundamental mode is kept unchanged, the high-Q multi-mode dielectric resonant structure formed by the dielectric resonators with dielectric materials with different dielectric constants, the cavity and the dielectric support frame, changes the Q value and the number of the multi-mode corresponding to the fundamental mode and changes the frequencies of the fundamental mode and the plurality of the high-order modes, the changes of the Inherent Q values of the dielectric resonators with the dielectric materials with different dielectric constants are different, and the frequency of the high-order mode can also be changed.

2. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein :

the cavity is internally provided with a dielectric resonator consisting of two vertically intersecting uniaxial cylinders or polygons and the fixed dielectric support frame thereof to form a high-Q multi-mode dielectric resonant structure with the cavity, the center of the end face of the dielectric resonator is closed to or coincided with the position, corresponding to the center of the inner wall surface, of the cavity, wherein the X-axis dimension of the cylindrical or polygonal dielectric resonator on the X-axis direction is greater than or equal to the perpendicular dimension, parallel to the X-axis, of the cylindrical or polygonal dielectric resonator with the Y-axis; wherein the Y-axis dimension of the cylinders or polygons on the Y-axis direction is greater than or equal to the perpendicular dimension, parallel to the Y-axis, of the cylinders or polygons with the X-axis; and the dielectric resonator is trimmed, slotted and chamfered in the horizontal and vertical directions, the inner wall dimension of the cavity thereof and the dimension of the three axial directions corresponding to the dielectric resonator are changed or the dimensions in the horizontal and vertical directions are changed, so as to change the Q value corresponding to the multi-mode , and change the frequency of the fundamental mode and the frequencies of the plurality of the high-order modes, while the X-axis, Y-axis and Z-axis dimensions of the inner wall of the cavity is changed, the X-axis, Y-axis and Z-axis dimensions of the dielectric resonator corresponding to the inner wall of the cavity can also be changed accordingly while a desired frequency is kept unchanged,

the cavity is internally provided with the dielectric resonators composed of three mutually vertically intersected single axial cylinders or polygons and the fixed dielectric support frame thereof to form a high-Q multi-mode dielectric resonant structure with the cavity, the center of the end face of the dielectric resonator is close to or coincided with the position, corresponding to the center of the inner wall surface, of the cavity, wherein the X-axis dimension of cylinders or polygons in X-axis direction of dielectric resonator is greater than or equal to the perpendicular dimensions, parallel to the X-axis, of the cylindrical or dielectric resonator with the Y-axis and the cylinders or polygons with the Z-axis; wherein the Y-axis dimension of the cylinders or polygons on the Y-axis direction is greater than or equal to the perpendicular dimensions, parallel to the Y-axis, of the cylindrical or polygonal dielectric resonator with the X-axis and the cylindrical or polygonal dielectric resonator with the Z-axis; wherein the Z-axis dimension of cylinders or polygons in Z-axis direction of dielectric resonator is greater than or equal to the perpendicular dimensions, parallel to the Z-axis, of the cylindrical

or polygonal dielectric resonator with the X-axis and the cylindrical or polygonal dielectric resonator with the Y-axis; and the dielectric resonator is trimmed, slotted and chamfered in the horizontal and vertical directions, while the dimension of the inner wall of the cavity thereof and the dimension of the three axial directions corresponding to the dielectric resonator are changed or the dimensions in the horizontal and vertical directions are changed, it changes the Q value corresponding to the fundamental mode, and the frequency of the fundamental mode and the frequencies of the plurality of the high-order modes, while the X-axis, Y-axis, and Z-axis dimensions of the inner wall of the cavity are changed, the X-axis, Y-axis, and Z-axis dimensions of the dielectric resonator corresponding to the inner wall of the cavity can also be changed accordingly while a desired frequency is kept unchanged, and

the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5.

3. The high-Q multi-mode dielectric resonant structure according to claim 1 or 2, wherein the dielectric resonator is through-slotted or blind-slotted along any axis, plane, slope and diagonal, and can be cut into different numbers of small dielectric resonator blocks, and the small dielectric resonator blocks can be fixed to form a dielectric resonator through dielectric or metal connecting block, or it is blind-cut so that the adjacent small dielectric resonator blocks are integrally connected to form the dielectric resonator ,

a slot width of a through slot or a blind slot in the above dielectric resonator is larger, the influence thereof on the frequency of the fundamental mode, the Q value is greater, and the slot width is smaller, the influence thereof on the frequency of the fundamental mode, the Q value is smaller,

while the medium or metal connecting block is made of metal, the Q value of the formed split dielectric resonator can be greatly reduced,

while the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5, the mode number corresponding to the frequencies of the fundamental mode is 1-N, where n is 2 to 6, and it changes the frequency of the fundamental mode and the frequencies of

multiple higher-order mode, and changes the Q value corresponding to the fundamental mode , and the dielectric resonator with different dielectric constants can affect the change of the frequency of the fundamental mode, the Q value, and the mode number thereof,

while the dimension ratio between the cavity and three axial dimensions of the dielectric resonators is changed, it changes the Q value corresponding to the fundamental mode and the frequency of the fundamental mode, and the frequencies of the plurality of the high-order modes .

4. The high-Q multi-mode dielectric resonant structure according to claim 3, wherein : while the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5, it changes the frequency of the fundamental mode and the frequencies of a plurality of the high-order modes ,and changes the Q value corresponding to the fundamental mode , and the Q values corresponding to the fundamental mode of the dielectric resonators with the different dielectric constants are different,

while the dimension ratio between the cavity and the three axial dimensions of dielectric resonators is changed, the corresponding fundamental mode Q value can also be changed accordingly.

5. The high-Q multi-mode dielectric resonant structure according to claim 3, wherein : while the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5, while the fundamental mode frequency thereof is kept unchanged, the interval between the high-order mode frequency and the fundamental mode frequency can be changed for many times, and the changes of the interval of the frequencies of the dielectric resonators with the different dielectric constants are different,

while the dimension ratio between the cavity and the three axial dimensions of dielectric resonators is changed, the corresponding fundamental mode and multi-mode frequency intervals can also be changed accordingly.

6. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein

adjacent coupling is formed by trimming, slotting and corner cutting at the intersection of two adjacent electric or magnetic fields of the dielectric resonator or/and the cavity , and the cavity and the dielectric resonator is cut into a triangle or a quadrilateral, or partial or whole edge cutting is performed at the edge of the cavity or the dielectric resonator, the cavity and the dielectric resonator are side-cut at the same time or side-cut separately, and after the adjacent coupling is formed by the side-cutting, the frequency and the Q value can be changed accordingly, and the adjacent coupling can also affect the strength of the cross coupling thereof.

7. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein : the cross coupling is formed by trimming, slotting and corner cutting at the position of the cross structure with 180 ° phase difference of the electric field or magnetic field not adjacent to the dielectric resonator or cavity, and the corresponding frequency and Q value can also be changed accordingly, and it can also affect the strength of the adjacent coupling.

8. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein at least one tuning device is arranged in a position in which the field strength of the electromagnetic field of the dielectric resonator is concentrated.

9. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the shape of the cavity corresponding to the dielectric resonator comprises a cuboid, a cube, and a polygon, and the inner wall surface of the cavity or a part of an inner region can be provided with a concave or a convex or a cut corner or a slot.

10. The high-Q multi-mode dielectric resonant structure according to claim 8, wherein the cavity material is metal or non-metal, and the surfaces of the metal and non-metal of the cavity are electro-plated with copper or electro-plated with silver.

11. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the cross-sectional shape of the dielectric resonators comprises a circle, an ellipse and a polygon.

12. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the surface or the inner region of the dielectric resonator can be partially provided with a concave or a convex or a cut corner or a slot or an edge.

13. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the dielectric resonators are solid or hollow.

14. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the dielectric resonator material is a ceramic, a composite dielectric material, or a dielectric material with a dielectric constant greater than 1.

15. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the dielectric support frame is located at the end face, the edge, and the intersection of three sides of the dielectric resonator or the intersection of three sides of the cavity, and is placed between the dielectric resonator and the cavity, the dielectric resonator is supported in the cavity by the dielectric support frame, while the dielectric support frame is mounted in different positions of the dielectric resonator, the multi-mode number corresponding to the fundamental mode , the frequency and the Q value thereof can also be changed accordingly,

the medium or metal connecting block can connect any two or more adjacent small dielectric resonator blocks, the medium or metal connecting block is located at any positions of the small dielectric resonator block, and the different numbers of the small dielectric resonator blocks can be fixed to form the dielectric resonator, and while the medium or metal connecting block is located at the different positions of the dielectric resonator, the multi-mode number corresponding to the fundamental mode , the frequency, and the Q value can also be changed accordingly,

while the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5, the Q values of the fundamental mode and the high-order mode are changed for many times,

while the dimension ratio between the cavity and the dimension of the three axial directions corresponding to the dielectric resonators is changed, it changes the frequency of the fundamental mode and the frequencies of the plurality of the high-order modes, and it changes the multi-mode number and Q value corresponding to the fundamental mode.

16. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the dielectric support frame and the dielectric resonator or the cavity are combined to

form an integrated structure or a split structure.

17. The high-Q multi-mode dielectric resonant structure according to claim 15, wherein the dielectric support frame of the dielectric resonators is made of the dielectric material, the material of the dielectric support frame is plastic or ceramic, composite dielectric material, and the medium or metal connecting block can be a dielectric or metal material.

18. The high-Q multi-mode dielectric resonant structure according to claim 15 or 16, wherein the dielectric support frame is connected with the dielectric resonator and the cavity by means of press-connecting, bonding, splicing, welding, snap-fitting or screw-fastening, and the dielectric support frame is connected to one or more end faces of the dielectric resonators,

the dielectric or metal connecting block is used to fix the small dielectric resonator block by means of the press-connecting, bonding, splicing, welding, snap-fitting or screw-fastening, a plurality of the small dielectric resonator blocks with arbitrary shapes is connected to form the dielectric resonator by the medium or metal connecting block.

19. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein:

the dielectric support frame comprises a solid with two parallel surfaces or a structure through the middle of the media support frame, and the number of the dielectric support frames at the same end face or different end faces, edges and sharp corners of the dielectric resonator is one or more different combinations, and the corresponding frequencies, mode number and Q value of the different numbers of the dielectric support frame can also be different, while the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5, the Q values of the fundamental mode and the high-order mode can be changed for many times,

the medium or metal connecting block is any shapes and is matched and mounted between two or more adjacent small dielectric resonator blocks, so that the plurality of the small dielectric resonator blocks is connected and fixed to form a split dielectric resonator, and the medium or metal connecting block comprises a solid or a structure

of which the middle is penetrated, and the number of the medium or metal connecting blocks at the same end face or different end faces, edges and sharp corners of the dielectric resonator is one or more different combinations, and the corresponding frequencies, mode number and Q value of the different numbers of the medium or metal connecting blocks can also be different, while the ratio of the dimension of the inner wall of the cavity to the dimension of the three axial directions corresponding to the dielectric resonator thereof or the ratio of the dimensions in the horizontal and vertical directions is between 1.01-4.5, the Q values of the fundamental mode and the high-order mode can be changed for many times,

while the dimension ratio between the three axial dimensions of dielectric resonators is changed, it changes the frequency of the corresponding fundamental mode and the frequencies of the plurality of the high-order modes, and it changes the multi-mode number and Q value corresponding to the fundamental mode .

20. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein an elastic spring sheet or an elastic dielectric material for stress relief is arranged between the dielectric support frame of the dielectric resonator and the inner wall of the cavity.

21. The high-Q multi-mode dielectric resonant structure according to claim 1, wherein the dielectric support frame of the dielectric resonator is in contact with the inner wall of the cavity to form heat conduction.

22. A dielectric filter comprising the high-Q multi-mode dielectric resonant structure according to any one of claims 1 to 21: wherein a high-Q multi-mode dielectric resonant structure forms 1-N single pass band filters with different frequencies, N is a natural number greater than 1, and the single pass band filters with the different frequencies form a multi-pass band filter, a duplexer or an combination of a multiplexer, or the corresponding high-Q multi-mode dielectric resonant structure and a single-mode resonant cavity, a double-mode resonant cavity and a three-mode resonant cavity of metal or dielectric are arranged and combined in different forms, so as to form the different dimensions of a plurality of the single pass band or multi-pass band filters, or form the duplexers or the combines of the multiplexers thereof consisting of multiple single band filters of different sizes required.

23. The dielectric filter according to claim 22, wherein the cavity corresponding to the high-Q multi-mode dielectric resonant structure performs combines of adjacent coupling or cross coupling with the metal or dielectric resonator single mode or multi-mode cavity.