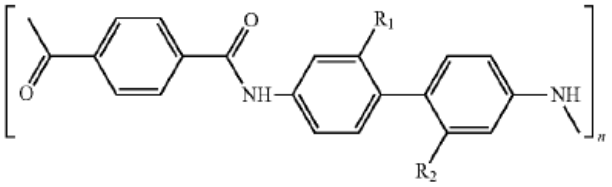
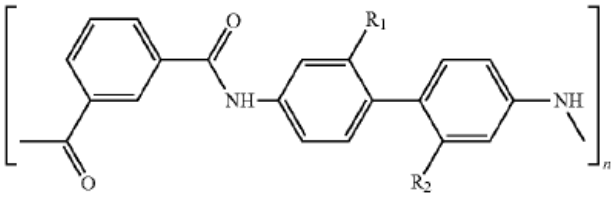
SUMMARY

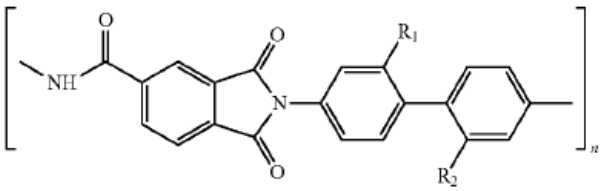
The present disclosure provides a coiled capacitor which may solve a problem of the further increase of volumetric and mass density of reserved energy associated with some energy storage devices, and at the same time reduce cost of materials.

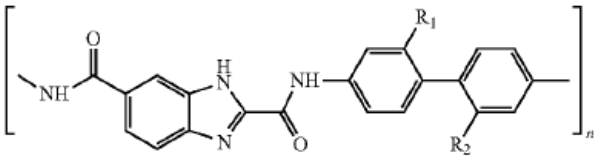
Aspects of the present disclosure include use of materials engineered to obtain 1) high permittivity, 2) high dielectric strength (also known as breakdown field E_{BB}) allowing high voltage, and 3) low amount of carrier substrate.

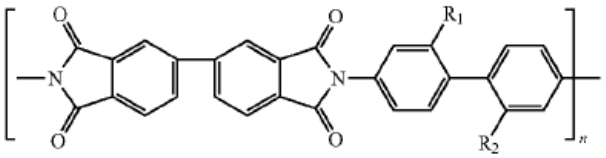
In an aspect, the present invention provides a coiled capacitor comprising a coil formed by a flexible multilayered tape, and a first terminating electrode (a first contact layer) and a second terminating electrode (a second contact layer) which are located on butts of the coil. The flexible multi-layered tape contains the following sequence of layers: first metal layer, a layer of a plastic, second metal layer, a layer of energy storage material. The first metal layer forms an ohmic contact with the first terminating electrode (the first contact layer) and the second metal layer (the second contact layer) forms an ohmic contact with the second terminating electrode. The energy storage material includes one or more structures selected from the list comprising structures 22 to 27:

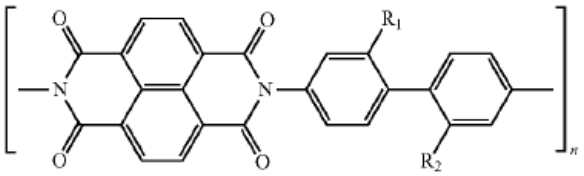












Each R_1 and R_2 is independently selected from alkyl, aryl, substituted alkyl, and substituted aryl.

INCORPORATION BY REFERENCE

All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1a, 1b and 1c schematically show formation of sets of metal strips on top and bottom surfaces of the plastic layer.

Figure 2 shows a formation of the layer of the energy storage material on one of metalized surfaces of the plastic layer.

Figure 3 shows a slitting of the intermediate product onto the multilayered tapes.

Figure 4 shows a winding of the multilayered tape.

Figure 5 shows a formation of the first terminating electrode and a second terminating electrode.

Figure 6 shows a formation of two metal strips on top and bottom surfaces of the plastic layer according to the second embodiment.

Figure 7 shows a formation of the layer of the energy storage material.

CLAIMS

What is claimed is:

1. A coiled capacitor comprising

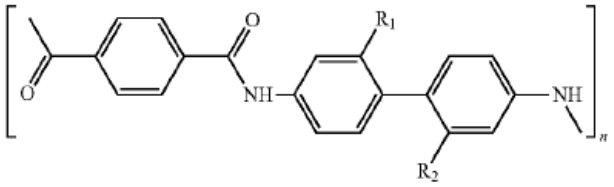
a coil formed by a flexible multilayered tape, and

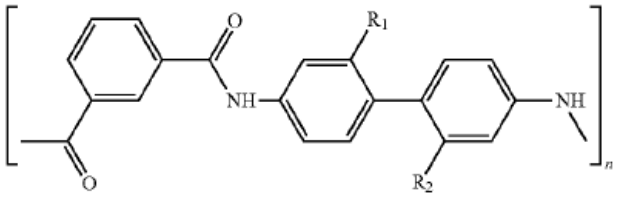
a first terminating electrode (a first contact layer) and a second terminating electrode (a second contact layer) which are located on butts of the coil,

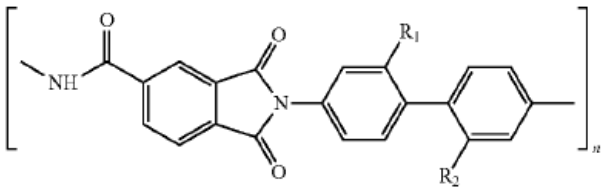
wherein the flexible multilayered tape contains the following sequence of layers: first metal layer, a layer of a plastic, second metal layer, a layer of energy storage material, and

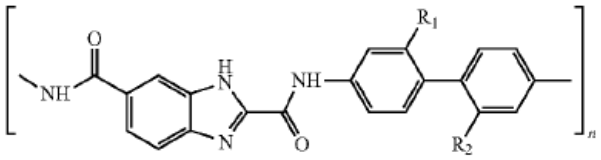
wherein the first metal layer forms ohmic contact with the first terminating electrode (the first contact layer) and the second metal layer (the second contact layer) forms ohmic contact with the second terminating electrode

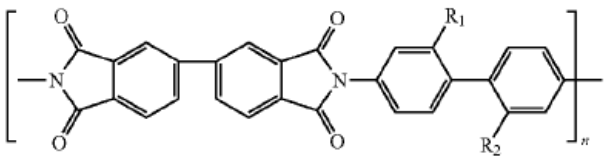
wherein the energy storage material includes one or more structures selected from the list comprising structures 22 to 27:

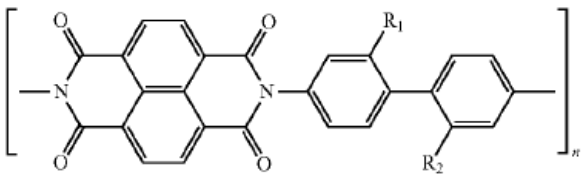












wherein each R_1 and R_2 is independently selected from alkyl, aryl, substituted alkyl, and substituted aryl.

2. A coiled capacitor according to claim 1, further comprises a dielectric core around which the flexible multilayered tape is coiled.

3. A coiled capacitor according to claim 1, wherein the energy storage material comprises a polymeric material soluble in organic solvents.

4. A coiled capacitor according to claim 1, wherein the energy storage material comprises ceramic slurries, sputtered thin films, or molecularly ordered crystals.

5. A coiled capacitor according to claim 1, wherein the plastic is selected from the list comprising polypropylene (PP), polyethylene terephthalate (PET), polyphenylene sulfide (PPS), polyethylene naphthalate (PEN), polycarbonate (PP), polystyrene (PS), and polytetrafluoroethylene (PTFE).

6. A coiled capacitor according to claim 5, wherein the thickness of the plastic layer varies from 2.5 μm to 52 μm.

7. A coiled capacitor according to claim 1, wherein the thickness of the plastic layer cannot be less than 2 μm.

8. A coiled capacitor according to claim 1, wherein the plastic layer comprises polypropylene and the thickness of the plastic layer is equal to 12 μm.

9. A coiled capacitor according to claim 1, wherein the plastic layer comprises polyethylene terephthalate (PET) and the thickness of the plastic layer is equal to 12 μm.

10. A coiled capacitor according to claim 1, wherein the material of the first metal layer and second metal layer independently selected from the list comprising Pt, Cu, Al, Ag, Au, Ni, Al:Ni and the metal foam.

11. A coiled capacitor according to claim 10, wherein the first or second metal layer is a metal foam and the metal of the metal foam is selected from the list comprising Aluminum (Al), Nickel (Ni), Iron (Fe), and Copper (Cu).

12. A coiled capacitor according to claim 10, wherein the first or second metal layer is a metal foam and a melting temperature of the metal foam is in the range 400 C.-700 C.

13. A coiled capacitor according to claim 10, wherein the first or second metal layer is a metal foam and metal content in the metal foam for electrode is in the range of 5% up to 30% by weight.

14. A coiled capacitor according to claim 10, wherein the first or second metal layer is a metal foam and the metal foam is of closed “bubble” type with maximum conductance per metal content.

15. A coiled capacitor according to claim 10, wherein the first or second metal layer is a metal foam and the size of “bubbles” in the metal foam is in a range from 100 nm to 100,000 nm.

16. A coiled capacitor according to claim 1, wherein the thickness of the first and second contact layers independently varies from 10 nm to 1000 nm.

17. A coiled capacitor according to claim 1, wherein the sheet resistance of the first and second contact layers independently cannot be less than 0.1 Ohm/Square.

18. A coiled capacitor according to claim 17, wherein the sheet resistance of the first and second contact layers independently varies from 0.1 Ohm/Square to 2.5 Ohm/Square.

19. A coiled capacitor according to claim 1, wherein the material of the first terminating electrode and second terminating electrode are independently selected from the list comprising Platinum (Pt), Copper (Cu), Aluminum (Al), Silver (Ag), and Gold (Au).

20. A coiled capacitor according to claim 1, wherein the first metal layer is deposited on a portion of a first surface of the plastic layer and the first surface has a first margin portion which is free of deposited metal, and wherein the second metal layer is deposited on a portion of a second surface of the plastic layer and this second surface has a second margin portion which is free of deposited metal and is located on an opposite edge of the plastic layer from the first margin portion.