

Claims

1. A sound-absorbing porous composite comprising:

5 (a) mechano-electrical conversion elements to convert sound mechanical energy into electric energy; and

(b) electro-thermal conversion elements to convert the converted electrical energy into thermal energy;

wherein said mechano-electrical conversion elements and electro-thermal conversion elements are homogenously mixed in said porous composite, and
10 wherein the porosity of said porous composite is at least 85%.

2. The sound-absorbing porous composite in accordance with Claim 1, wherein the mechano-electrical conversion elements comprise a piezoelectric polymer.

15 3. The sound-absorbing porous composite in accordance with Claim 1 or 2, wherein the mechano-electrical conversion elements comprise a polymeric electret.

20 4. The sound-absorbing porous composite in accordance with any one of Claims 1 to 3, wherein the electro-thermal conversion element(s) comprise electrical conductive elements.

25 5. The sound-absorbing porous composite in accordance with one or more Claims 1 to 4, wherein the electro-thermal conversion elements comprise dielectric lossy elements.

6. The sound-absorbing porous composite in accordance with Claim 2, wherein the piezoelectric polymer is selected from the group consisting of polyvinylidene fluoride (PVDF), PVDF-based polymers, homopolymer and copolymers containing

a major portion of vinylidene fluoride, poly(vinylidene fluoride-trifluoroethylene), poly(vinylidene fluoride-hexafluoropropylene) copolymers, poly(vinylidene fluoride-trifluoroethylene-chlorofluoroethylene) terpolymer, polyurea, polyamide, polyvinylidene chloride, and polyacrylonitrile.

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7. The sound-absorbing porous composite in accordance with Claim 3, wherein the polymeric electret is selected from the group consisting of polypropylene, polyurethane, polyethylene, polystyrene, polyethylene terephthalate, polytetrafluoroethylene, polyimide, polymethylmethacrylate, and ethylene vinyl acetate cyclic olefin copolymers.

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8. The sound-absorbing porous composite in accordance with Claim 1, wherein the mechano-electrical conversion elements comprise a blend of a piezoelectric polymer and a polymer electret.

15 9. The sound-absorbing porous composite in accordance with Claim 4, wherein the electrical conductive elements are selected from the group consisting of carbon nanotubes, graphene, carbon black, and conductive metal particles.

10. The sound-absorbing porous composite in accordance with Claim 5, wherein the lossy elements are selected from the group consisting of hydrated or hygroscopic materials.

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11. The sound-absorbing porous composite in accordance with Claim 4 or 9, wherein the concentration of the conductive elements is near conductivity percolation threshold.

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12. The sound-absorbing porous composite in accordance with Claim 5 or 10, wherein the concentration of lossy element is ≥ 10 wt % of said composite.

13. The sound-absorbing porous composite in accordance with any one of Claims 1 to 12, wherein the porous composite is cellular type with open-cell pores.

14. The sound-absorbing porous composite in accordance with any one of Claims 1 to 13, wherein the pore size is in range of 50-600 μm .

15. The sound-absorbing porous composite in accordance with any one of Claims 1, 2, 4, 6, 9, 11, 13 and 14, wherein the composite comprises polyvinylidene fluoride (PVDF)-based polymer as the mechano-electric conversion elements and 3 - 5 wt% carbon nanotubes as the electro-thermal conversion elements.

16. The sound-absorbing porous composite in accordance with any one of Claims 1, 2, 4, 6, 8, 11, 13, 14, and 15, wherein said composite comprises polyvinylidene fluoride (PVDF)-based polymer as the mechano-electric conversion elements and about 9 wt% aluminum microparticles as the electro-thermal conversion elements.

17. The sound-absorbing porous composite in accordance with any one of Claims 1, 3, 4, 7, 9, 11, 13 and 14, wherein said composite comprises polypropylene, polyurethane, polyethylene, polystyrene, polyethylene terephthalate, polytetrafluoroethylene, polyimide, polymethylmethacrylate, or ethylene vinyl acetate cyclic olefin copolymers as the mechano-electric conversion elements and 3-5 wt% carbon nanotube as the electro-thermal conversion elements.

18. The sound-absorbing porous composite in accordance with any one of Claims 1 to 17, wherein the sound absorption coefficient for the porous composite is ≥ 0.50 at audible frequencies above 800 Hz with a thickness of 25 mm.

19. The sound-absorbing porous composite in accordance with any one of 1 to 17, wherein the sound absorption coefficient for the porous composite is not lower than about ≥ 0.90 at audible frequencies above 1.5 kHz with a thickness of 25 mm.

20. A method for absorbing sound, comprising the following steps:

(i) providing a sound-absorbing porous composite comprising:

(a) one or more mechano-electrical conversion element(s); and

(b) one or more electro-thermal conversion element(s);

5 wherein said mechano-electrical conversion element(s) and electro-thermal conversion element(s) are homogenously mixed in said porous composite, and wherein the porosity of said porous composite is at least 85%;

10 (ii) converting sound mechanical energy into electric energy via said mechano-electrical conversion element(s);

(iii) converting the electrical energy produced by step (ii) into thermal energy via said electro-thermal conversion element(s).