Claims

1. A sound-absorbing porous composite comprising:

(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 wherein the porosity of said porous composite is at least 85%, and wherein:

(i) the mechano-electrical conversion elements comprise polymeric electret; or

(ii) the mechano-electrical conversion elements comprise piezoelectric polymer when the electro-thermal conversion elements comprise dielectric lossy elements.

2. A sound-absorbing porous composite when used to absorb sound, comprising:

(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 wherein the porosity of said porous composite is at least 85%, and wherein:

(i) the mechano-electrical conversion elements comprise polymeric electret; or

(ii) the mechano-electrical conversion elements comprise piezoelectric polymer when the electro-thermal conversion elements comprise dielectric lossy elements; or

(iii) the mechano-electrical conversion elements comprise piezoelectric polymer when the electro-thermal conversion elements comprise electrical conductive elements, wherein the concentration of said conductive elements is near conductivity percolation threshold.

3. The sound-absorbing porous composite in accordance with Claim 1 or 2, wherein the electro-thermal conversion element(s) comprise electrical conductive elements.

4. The sound-absorbing porous composite in accordance with Claim 1 or 2, wherein the electro-thermal conversion elements comprise dielectric lossy elements.

5. The sound-absorbing porous composite in accordance with any one of Claims 1 to 4, 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) and terpolymer.

6. The sound-absorbing porous composite in accordance with any one of Claims 1 to 4, 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.

7. The sound-absorbing porous composite in accordance with any one of Claims 1 to 6, wherein the mechano-electrical conversion elements comprise a blend of a piezoelectric polymer and a polymer electret.

8. The sound-absorbing porous composite in accordance with any one of Claims 1 to 3 and 5 to 7, wherein the electrical conductive elements are selected from the group consisting of carbon nanotubes, graphene, carbon black, and conductive metal particles.

9. The sound-absorbing porous composite in accordance with any one of Claims 1, 2 and 4 to 7, wherein the lossy elements are selected from the group consisting of hydrated or hygroscopic materials.

10. The sound-absorbing porous composite in accordance with any one of Claims 1 to 3, and 5 to 8, wherein the electro-thermal conversion elements comprise electrical conductive elements, and the concentration of the conductive elements is near conductivity percolation threshold.

11. The sound-absorbing composite in accordance with any one of Claims 1 to 3, 5 to 8 and 10, wherein the electro-thermal conversion elements comprise electrical conductive elements, and the concentration of the conductive elements is 3 wt% to 10 wt%.

12. The sound-absorbing porous composite in accordance with any one of Claims 1, 2, 4 to 7 and 9, 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 Claim 2, 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, 5, 7, 9 and 12 to 14, 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 to 3, 6 to 8, 10, 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);

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%, and wherein

(i) the mechano-electrical conversion elements comprise polymeric electret, or

(ii) the mechano-electrical conversion elements comprise piezoelectric polymer when the electro-thermal conversion elements comprise dielectric lossy elements, or

(iii) the mechano-electrical conversion elements comprise piezoelectric polymer when the electro-thermal conversion elements comprise electrical conductive elements, wherein the concentration of said conductive elements is near conductivity percolation threshold;

(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).