

CLAIMS:

1. A method for concentrating particles in a primary fluid at a first location, comprising:
 - flowing a fluid mixture comprising the particles and the primary fluid through an acoustophoretic device that comprises:
 - an acoustic chamber through which the fluid mixture flows;
 - and
 - an ultrasonic transducer including a piezoelectric material that can be driven to create an acoustic wave in the acoustic chamber;
 - and
 - driving the ultrasonic transducer to create the acoustic wave;wherein the acoustic wave concentrates the particles at the first location.
2. The method of claim 1, wherein the acoustic wave is a multi-dimensional acoustic standing wave, a planar acoustic standing wave, a combination of a multi-dimensional acoustic standing wave and a planar acoustic standing wave, or an acoustic traveling wave.
3. The method of claim 1, wherein the particles contain a payload.
4. The method of claim 3, wherein the payload is a virus, a nucleic acid, a cytokine, a pharmaceutical molecule, a liquid, a gas, or mixtures thereof.
5. The method of claim 3, further comprising releasing the payload from the particles at the first location.
6. The method of claim 1, wherein the particles are solid, cellular, hollow, or a foam.
7. The method of claim 1, wherein the particles are made of one or more polymeric materials, ionomers, ceramics, or glass.
8. The method of claim 7, wherein the one or more polymeric materials are selected from the group consisting of polyethylene, polypropylene, polystyrene, divinylbenzene, poly methyl methacrylate, polysaccharide, polylactic acid (PLA), and poly(lactic-co-glycolic acid) (PLGA).

9. The method of claim 1, wherein the particles are formed from multiple layers of polymeric materials.

10. The method of claim 1, wherein the particles are hollow, and are made of glass, and have an ablative polymer coating an exterior surface of the glass.

11. The method of claim 10, wherein the ablative polymer is a polysaccharide that is functionalized with an antigen, antibody, or protein.

12. The method of claim 1, wherein the particles comprise:
a liquid core; and
a lipid shell encapsulating the liquid core.

13. The method of claim 12, wherein the liquid in the liquid core comprises a perfluorocarbon.

14. The method of claim 13, wherein the perfluorocarbon is perfluoropentane, perfluorohexane, perfluorooctane, perfluorooctyl bromide, perfluorodichlorooctane, or perfluorodecalin.

15. The method of claim 12, wherein the lipid shell is formed from dipalmitoylphosphatidylcholine (DPPC), 1,2-palmitoyl-phosphatidic acid (DPPA), a lipid-polyethylene glycol conjugate, or a complex of a lipid with albumin.

16. The method of claim 12, wherein the lipid shell is functionalized with streptavidin, biotin, avidin, or an antibody.

17. A particle, comprising:
a liquid core; and
a lipid shell encapsulating the liquid core.

18. The particle of claim 17, wherein the liquid in the liquid core comprises a perfluorocarbon.

19. The particle of claim 18, wherein the perfluorocarbon is perfluoropentane, perfluorohexane, perfluorooctane, perfluorooctyl bromide, perfluorodichlorooctane, or perfluorodecalin.

20. The particle of claim 17, wherein the lipid shell is formed from dipalmitoylphosphatidylcholine (DPPC), 1,2-palmitoyl-phosphatidic acid (DPPA), a lipid-polyethylene glycol conjugate, or a complex of a lipid with albumin.

21. The particle of claim 17, wherein the lipid shell is functionalized with streptavidin, biotin, avidin, or an antibody.

22. A method for separating target particles from a fluid, comprising:
receiving functionalized particles in the fluid in a chamber;
receiving target particles in the chamber;
permitting the target particles to bind with the functionalized particles;
applying an acoustic wave to the chamber to influence the functionalized particles to be collected or blocked by the acoustic wave.

23. The method of claim 22, wherein the functionalized particles comprise a perfluorocarbon that is one or more of perfluoropentane, perfluorohexane, perfluorooctane, perfluorooctyl bromide, perfluorodichlorooctane, or perfluorodecalin