[0006a] In one aspect, the present disclosure provides a battery, comprising an anode; an electrolyte; and a cathode current collector contacting the electrolyte, wherein the electrolyte facilitates transport of ions between the anode and the cathode current collector, wherein the electrolyte comprises: (i) a mixed-solvent comprising at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}\ R^1$, wherein, n is an integer greater than 0, R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent, (ii) a metal halide that functions as an active cathode material, wherein the metal halide is dissolved in the mixed-solvent, and (iii) an oxidizing gas dissolved in the mixed-solvent.

[0007] In an embodiment, the present invention relates to an electrolyte for a rechargeable battery comprising: (i) a mixed-solvent comprising at least two organic liquid compounds, wherein at least one of the organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}C\ R^1$, wherein, n is an integer greater than 0, R^1 and R^2 are independently substituted or unsubstituted alky, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent, (ii) a metal halide dissolved in the mixed-solvent, and (iii) an oxidizing gas dissolved in the mixed-solvent.

[0007a] In another aspect, there is provided electrolyte for a rechargeable battery comprising (i) a mixed-solvent comprising at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}\ R^1$, wherein, n is an integer greater than 0, R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl; and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent, (ii)a metal halide dissolved in the mixed-solvent, and (iii) an oxidizing gas dissolved in the mixed-solvent.

[0008] In a further embodiment, the present invention relates to a rechargeable battery, comprising: an anode; a cathode current collector; and an electrolyte that facilitates transport of ions between the anode and the cathode current collector, wherein the cathode current collector is in contact with the electrolyte and the electrolyte comprises: (i) lithium iodide dissolved in a mixed-solvent, and an oxidizing gas dissolved in the mixed-solvent, wherein the mixed-solvent comprises 1,2-dimethoxyethane and (ii) at least one additional organic compound.

[0008a] In yet another aspect, there is provided a rechargeable battery, comprising an anode; a cathode current collector; and an electrolyte that facilitates transport of ions between the anode and the cathode current collector, wherein the cathode current collector is in contact with the electrolyte and the electrolyte comprises (i) lithium iodide

dissolved in a mixed-solvent and (ii) an oxidizing gas dissolved in the mixed-solvent, wherein the mixed-solvent comprises 1,2-dimethoxyethane, ethylene glycol bis(propionitrile) and at least one additional organic compound.

[0009] In an embodiment, the anode comprises one or more alkali metals and/or one or more alkali earth metals.

[0010] In an embodiment, the cathode current collector comprises a porous carbon material and/or a metal.

[0011] In an embodiment, the porous carbon material is selected from the group consisting of carbon cloth, carbon nanoparticles, polymer binders, and combinations thereof.

[0012] In one aspect, the present invention relates to a method of preparing an electrolyte for a metal halide rechargeable battery, the method comprising: dissolving a metal halide in a mixed-solvent solution; and introducing an oxidizing gas into the mixed-solvent solution, wherein the mixed-solvent solution comprises at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}C\ R^1$, wherein, n is an integer greater than 0, R^1 and R^2 are independently substituted or unsubstituted alky, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0012a] In a further aspect, the present disclosure provides method of preparing an electrolyte for a metal halide rechargeable battery, the method comprising dissolving a metal halide in a mixed-solvent solution; and introducing an oxidizing gas into the mixed-solvent solution, wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}\ R^1$, wherein, n is an integer greater than 0, R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0013] In another aspect, the present invention relates to a method of fabricating a metal halide rechargeable battery, the method comprising: dissolving a metal halide in a mixed-solvent solution to form an electrolyte solution; forming a soaked separator by soaking a separator in the electrolyte solution; forming a stack comprising an anode, the soaked separator, and a cathode current collector, wherein the soaked separator is placed between the anode and the cathode current collector, the cathode current collector is in contact with the electrolyte, and the electrolyte facilitates transport of ions between the anode and the cathode current collector; introducing an oxidizing gas into the stack, wherein the mixed-solvent solution comprises at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}C\ R^1$, wherein, n is an integer greater than 0, R^1 and R^2 are independently substituted or unsubstituted alky,

alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0013a] In another aspect, there is provided a method of fabricating a metal halide rechargeable battery, the method comprising dissolving a metal halide in a mixed-solvent solution to form an electrolyte solution; forming a soaked separator by soaking a separator in the electrolyte solution; forming a stack comprising an anode, the soaked separator, and a cathode current collector, wherein the soaked separator is placed between the anode and the cathode current collector, the cathode current collector is placed in contact with the electrolyte solution, and the metal halide acts as an active cathode material; introducing an oxidizing gas into the stack, wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}\ R^1$, wherein, n is an integer greater than 0, R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0014] In a further aspect, the present invention relates to a method of preparing an electrolyte for a metal halide rechargeable battery, the method comprising: mixing a metal halide, an oxidizing gas, and ingredients of a mixed-solvent solution, wherein the mixed-solvent solution comprises at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}C\ R^1$, wherein, n is an integer greater than 0, R^1 and R^2 are independently substituted or unsubstituted alky, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0014a] In yet another aspect, there is provided a method of preparing an electrolyte for a metal halide rechargeable battery, the method comprising combining a metal halide, an oxidizing gas, and ingredients of a mixed-solvent solution, wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}C\ R^1$, wherein n is an integer greater than 0, R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0015] In another aspect, the present invention relates to a method of fabricating a metal halide rechargeable battery, the method comprising: mixing a metal halide, an oxidizing gas, and ingredients of a mixed-solvent solution to form an electrolyte solution; forming a soaked separator by soaking a separator in the electrolyte solution; forming a stack comprising an anode, the soaked separator, and a cathode current collector, wherein the soaked separator is

placed between the anode and the cathode current collector, the cathode current collector is placed in contact with the electrolyte solution, and the metal halide acts as an active cathode material; wherein the mixed-solvent solution comprises at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, R^1O-$(CR^2_2C\ R^2_2O)_n$-$C\ R^1$, wherein, n is an integer greater than 0, R^1 and R^2 are independently substituted or unsubstituted alky, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0015a] In a further aspect, there is provided a method of fabricating a metal halide rechargeable battery, the method comprising forming an electrolyte solution comprising a metal halide, an oxidizing gas, and ingredients of a mixed-solvent solution; forming a soaked separator by soaking a separator in the electrolyte solution; and forming a stack comprising an anode, the soaked separator, and a cathode current collector, wherein the soaked separator is placed between the anode and the cathode current collector, the cathode current collector is placed in contact with the electrolyte solution, and the metal halide acts as an active cathode material; mwherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, R^1O-$(CR^2_2C\ R^2_2O)_n$- R^1, wherein, n is an integer greater than 0, R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

[0016] In other embodiments and aspects, each R^1 and each R^2 are independently selected from the group consisting of a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl.

[0017] In further embodiments and aspects, each R^1 and each R^2 are independently selected from the group consisting of a C_1-C_{10} linear alkyl halide, a C_3-C_{10} branched alkyl halide, a C_3-C_{10} cyclic halide alkyl group, a C_2-C_{10} linear alkenyl halide group, a C_3-C_{10} branched alkenyl halide group, a C_3-C_{10} cyclic alkenyl halide group, and a C_5-C_{10} aryl halide group.

[0018] In other embodiments and aspects, each R^1 and each R^2 are independently selected from the group consisting of an X_1-X_{10} linear alkyl, an X_3-X_{10} branched alkyl, a X_3-X_{10} cyclic alkyl, a X_2-X_{10} linear alkenyl, a X_3-X_{10} branched alkenyl, a X_3-X_{10} cyclic alkenyl, and a X_5-X_{10} aryl, wherein each X is a carbon, a nitrogen, an oxygen, or a silicon atom.

CLAIMS

1. A battery, comprising:

an anode;

an electrolyte; and

a cathode current collector contacting the electrolyte, wherein the electrolyte facilitates transport of ions between the anode and the cathode current collector,

wherein the electrolyte comprises:

(i) a mixed-solvent comprising at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O-(CR^2_2C\ R^2_2O)_n-\ R^1$, wherein,

n is an integer greater than 0,

R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl,

R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and

the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent,

(ii) a metal halide that functions as an active cathode material, wherein the metal halide is dissolved in the mixed-solvent, and

(iii) an oxidizing gas dissolved in the mixed-solvent.

2. The battery of claim 1, wherein each R^1 is independently selected from the group consisting of a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl, and each R^2 is independently selected from the group consisting of hydrogen, a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl.

3. The battery of claim 2, wherein at least one hydrogen atom of the linear, branched, or cyclic alkyl, alkenyl, and aryl R^1 and/or R^2 groups is substituted with a halogen atom.

4. The battery of claim 2, wherein at least one carbon atom of the linear, branched, or cyclic alkyl, alkenyl, and aryl R^1 and/or R^2 groups is replaced with a nitrogen, an oxygen, or a silicon atom.

5. The battery of claim 1, wherein the glyme-based compound is 1,2-dimethoxyethane.

6. The battery of claim 1, wherein the metal halide is lithium iodide.

7. The battery of claim 1, wherein the mixed-solvent comprises a heterocyclic compound.

8. The battery of claim 7, wherein the heterocyclic compound is 1,3-dioxolane.

9. The battery of claim 1, wherein the electrolyte further comprises:

(iv) an additional lithium salt selected from the group consisting of lithium nitrate ($LiNO_3$), lithium fluoride (LiF), lithium bis(trifluoromethanesulfonyl)imide (LiTFSI; $LiC_2F_6NO_4S_2$), lithium trifluoromethanesulfonate ($LiCF_3SO_3$), lithium hexafluorophosphate ($LiPF_6$), lithium hexafluoroarsenate ($LiAsF_6$), lithium perchlorate ($LiClO_4$), and lithium tetrafluoroborate ($LiBF_4$).

10. The battery of claim 1, wherein the anode comprises one or more alkali metals and/or one or more alkali earth metals.

11. The battery of claim 1, wherein the cathode current collector comprises a porous carbon material and/or a metal.

12. The battery of claim 1, wherein the porous carbon material is selected from the group consisting of carbon cloth, carbon nanoparticles, polymer binders, and combinations thereof.

13. The battery of claim 1, wherein the oxidizing gas is selected from the group consisting of oxygen, air, nitric oxide, nitrogen dioxide, and mixtures and combinations thereof.

14. The battery of claim 1, wherein the metal halide is dissolved in the mixed-solvent at a cathode loading amount of > 25 mg/cm^2 (metal halide/cathode surface area).

15. The battery of claim 1, wherein the metal halide is dissolved in the mixed-solvent at a cathode loading amount of 24-31 mg/cm^2 (metal halide/cathode surface area).

16. The battery of claim 1, wherein the metal halide is dissolved in the mixed-solvent at a cathode loading amount of at least 28 mg/cm^2 (metal halide/cathode surface area).

17. The battery of claim 1, wherein the metal halide is dissolved in the mixed-solvent at a cathode loading amount of at least 31 mg/cm^2 (metal halide/cathode surface area).

18. An electrolyte for a rechargeable battery comprising:

(i) a mixed-solvent comprising at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the organic liquid compounds is a glyme-based compound having the chemical formula, R^1O-(CR^2_2C $R^2_2O)_n$-R^1, wherein,

n is an integer greater than 0,

R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl,

R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl; and

the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent,

(ii) a metal halide dissolved in the mixed-solvent, and

(iii) an oxidizing gas dissolved in the mixed-solvent.

19. The electrolyte of claim 18, wherein each R^1 is independently selected from the group consisting of a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl; and each R^2 is independently selected from the group consisting of hydrogen, a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl.

20. The electrolyte of claim 18, wherein each R^1 is independently selected from the group consisting of a C_1-C_{10} linear alkyl halide, a C_3-C_{10} branched alkyl halide, a C_3-C_{10} cyclic halide alkyl group, a C_2-C_{10} linear alkenyl halide group, a C_3-C_{10} branched alkenyl halide group, a C_3-C_{10} cyclic alkenyl halide group, and a C_5-C_{10} aryl halide group; and each R^2 is independently selected from the group consisting of hydrogen, a C_1-C_{10} linear alkyl halide, a C_3-C_{10} branched alkyl halide, a C_3-C_{10} cyclic halide alkyl group, a C_2-C_{10} linear alkenyl halide group, a C_3-C_{10} branched alkenyl halide group, a C_3-C_{10} cyclic alkenyl halide group, and a C_5-C_{10} aryl halide group.

21. The electrolyte of claim 18, wherein each R^1 is independently selected from the group consisting of an X_1-X_{10} linear alkyl, an X_3-X_{10} branched alkyl, a X_3-X_{10} cyclic alkyl, a X_2-X_{10} linear alkenyl, a X_3-X_{10} branched alkenyl, a X_3-X_{10} cyclic alkenyl, and a X_5-X_{10} aryl, wherein each X is a carbon, a nitrogen, an oxygen, or a silicon atom; and each R^2 is independently selected from the group consisting of hydrogen, an X_1-X_{10} linear alkyl, an X_3-X_{10} branched alkyl, a X_3-X_{10} cyclic alkyl, a X_2-X_{10} linear alkenyl, a X_3-X_{10} branched alkenyl, a X_3-X_{10} cyclic alkenyl, and a X_5-X_{10} aryl, wherein each X is a carbon, a nitrogen, an oxygen, or a silicon atom.

22. The electrolyte of claim 18, wherein the mixed-solvent comprises a heterocyclic compound.

23. The electrolyte of claim 18, further comprising:

(iv) a lithium salt selected from the group consisting of lithium nitrate ($LiNO_3$), lithium fluoride (LiF), lithium bis(trifluoromethanesulfonyl)imide (LiTFSI; $LiC_2F_6NO_4S_2$), lithium trifluoromethanesulfonate ($LiCF_3SO_3$), lithium hexafluorophosphate ($LiPF_6$), lithium hexafluoroarsenate ($LiAsF_6$), lithium perchlorate ($LiClO_4$), and lithium tetrafluoroborate ($LiBF_4$).

24. The electrolyte of claim 18, wherein the oxidizing gas is selected from the group consisting of oxygen, air, nitric oxide, nitrogen dioxide, and mixtures and combinations thereof.

25. A rechargeable battery, comprising:

an anode;

a cathode current collector; and

an electrolyte that facilitates transport of ions between the anode and the cathode current collector, wherein the cathode current collector is in contact with the electrolyte and the electrolyte comprises: (i) lithium iodide dissolved in a mixed-solvent and (ii) an oxidizing gas dissolved in the mixed-solvent, wherein the mixed-solvent comprises 1,2-dimethoxyethane, ethylene glycol bis(propionitrile) and at least one additional organic compound.

26. The rechargeable battery of claim 25, wherein the at least one additional organic compound is a heterocyclic compound.

27. The rechargeable battery of claim 25, wherein the electrolyte comprises an additional lithium salt selected from the group consisting of lithium nitrate ($LiNO_3$), lithium fluoride (LiF), lithium bis(trifluoromethanesulfonyl)imide

(LiTFSI; $LiC_2F_6NO_4S_2$), lithium trifluoromethanesulfonate ($LiCF_3SO_3$), lithium hexafluorophosphate ($LiPF_6$), lithium hexafluoroarsenate ($LiAsF_6$), lithium perchlorate ($LiClO_4$), and lithium tetrafluoroborate ($LiBF_4$).

28. The rechargeable battery of claim 25, wherein the anode comprises one or more alkali metals and/or one or more alkali earth metals.

29. The rechargeable battery of claim 25, wherein the cathode current collector comprises a porous carbon material and/or a metal.

30. The rechargeable battery of claim 25, wherein the oxidizing gas is selected from the group consisting of oxygen, air, nitric oxide, nitrogen dioxide, and mixtures and combinations thereof.

31. The rechargeable battery of claim 25, wherein the lithium iodide is dissolved in the mixed-solvent at a cathode loading amount of > 25 mg/cm^2 (lithium iodide/cathode surface area).

32. The rechargeable battery of claim 25, wherein the lithium iodide is dissolved in the mixed-solvent at a cathode loading amount of 24-31 mg/cm^2 (lithium iodide/cathode surface area).

33. The rechargeable battery of claim 25, wherein the lithium iodide is dissolved in the mixed-solvent at a cathode loading amount of at least 28 mg/cm^2 (lithium iodide/cathode surface area).

34. The rechargeable battery of claim 25, wherein the lithium iodide is dissolved in the mixed-solvent at a cathode loading amount of at least 31 mg/cm^2 (lithium iodide/cathode surface area).

35. A method of preparing an electrolyte for a metal halide rechargeable battery, the method comprising:
dissolving a metal halide in a mixed-solvent solution; and
introducing an oxidizing gas into the mixed-solvent solution,
wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}R^1$, wherein,
n is an integer greater than 0,
R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl,
R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and

the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

36. The method of claim 35, wherein each R^1 is independently selected from the group consisting of a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl, and each R^2 is independently selected from the group consisting of hydrogen, a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl.

37. The method of claim 35, wherein at least one hydrogen atom of the linear, branched, or cyclic alkyl, alkenyl, and aryl R^1 and/or R^2 groups is substituted with a halogen atom.

38. The method of claim 35, wherein at least one carbon atom of the linear, branched, or cyclic alkyl, alkenyl, and aryl R^1 and/or R^2 groups is replaced with a nitrogen, an oxygen, or a silicon atom.

39. The method of claim 35, wherein the mixed-solvent solution comprises a heterocyclic compound.

40. A method of fabricating a metal halide rechargeable battery, the method comprising:

dissolving a metal halide in a mixed-solvent solution to form an electrolyte solution;

forming a soaked separator by soaking a separator in the electrolyte solution;

forming a stack comprising an anode, the soaked separator, and a cathode current collector, wherein the soaked separator is placed between the anode and the cathode current collector, the cathode current collector is placed in contact with the electrolyte solution, and the metal halide acts as an active cathode material;

introducing an oxidizing gas into the stack,

wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, R^1O-$(CR^2_2C\ R^2_2O)_n$-R^1, wherein,

n is an integer greater than 0,

R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl,

R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and

the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

41. The method of claim 40, wherein each R^1 is independently selected from the group consisting of a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl; and each R^2 is independently selected from the group consisting of hydrogen, a C_1-C_{10} linear alkyl, a C_3-C_{10} branched alkyl, a C_3-C_{10} cyclic alkyl, a C_2-C_{10} linear alkenyl, a C_3-C_{10} branched alkenyl, a C_3-C_{10} cyclic alkenyl, and a C_5-C_{10} aryl.

42. The method of claim 40, wherein at least one hydrogen atom of the linear, branched, or cyclic alkyl, alkenyl, and aryl R^1 and/or R^2 groups is substituted with a halogen atom.

43. The method of claim 40, wherein at least one carbon atom of the linear, branched, or cyclic alkyl, alkenyl, and aryl R^1 and/or R^2 groups is replaced with a nitrogen, an oxygen, or a silicon atom.

44. The method of claim 40, wherein the mixed-solvent solution comprises a heterocyclic compound.

45. The method of claim 40, wherein the metal halide is dissolved in the mixed-solvent solution at a cathode loading amount of > 25 mg/cm^2 (metal halide/cathode surface area).

46. The method of claim 40, wherein the metal halide is dissolved in the mixed-solvent solution at a cathode loading amount of 24-31 mg/cm^2 (metal halide/cathode surface area).

47. The method of claim 40, wherein the metal halide is dissolved in the mixed-solvent solution at a cathode loading amount of at least 28 mg/cm^2 (metal halide/cathode surface area).

48. The method of claim 40, wherein the metal halide is dissolved in the mixed-solvent solution at a cathode loading amount of at least 31 mg/cm^2 (metal halide/cathode surface area).

49. A method of preparing an electrolyte for a metal halide rechargeable battery, the method comprising:

combining a metal halide, an oxidizing gas, and ingredients of a mixed-solvent solution, wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, R^1O-$(CR^2_2C\ R^2_2O)_n$-$C\ R^1$, wherein,

n is an integer greater than 0,

R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl,

R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and

the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.

50. A method of fabricating a metal halide rechargeable battery, the method comprising:

forming an electrolyte solution comprising a metal halide, an oxidizing gas, and ingredients of a mixed-solvent solution;

forming a soaked separator by soaking a separator in the electrolyte solution; and

forming a stack comprising an anode, the soaked separator, and a cathode current collector, wherein the soaked separator is placed between the anode and the cathode current collector, the cathode current collector is placed in contact with the electrolyte solution, and the metal halide acts as an active cathode material;

wherein the mixed-solvent solution comprises at least ethylene glycol bis(propionitrile) and at least two organic liquid compounds, wherein at least one of the at least two organic liquid compounds is a glyme-based compound having the chemical formula, $R^1O\text{-}(CR^2_2C\ R^2_2O)_n\text{-}\ R^1$, wherein,

n is an integer greater than 0,

R^1 is independently substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl,

R^2 is independently hydrogen, substituted or unsubstituted alkyl, alkenyl, alkynyl, aryl, or alkylaryl, and

the glyme-based compound has a volume fraction between 20-70 volume % of the mixed-solvent solution.