CLAIMS

What is claimed is:

1. A cathode slurry for a secondary battery, comprising a cathode active material, a polymeric binder, a lithium compound, and an aqueous solvent; wherein the lithium compound is a compound represented by the chemical formula:

$$[A^+]_aB^{a-}$$

wherein the cation A+ is Li+, a is an integer from 1 to 10, and the anion B^{a-} is an oxidizable anion; wherein the solubility ratio of the lithium compound is greater than or equal to 1; wherein the polymeric binder comprises a structural unit (a) derived from a monomer selected from the group consisting of a carboxylic acid group-containing monomer, a sulfonic acid group-containing monomer, a phosphonic acid group-containing monomer, a carboxylic acid salt group-containing monomer, a sulfonic acid salt group-containing monomer, a phosphonic acid salt group-containing monomer, and combinations thereof; a structural unit (b) derived from a monomer selected from the group consisting of an amide group-containing monomer, a hydroxyl group-containing monomer, and combinations thereof; and a structural unit (c) derived from a monomer selected from the group consisting of a nitrile group-containing monomer, an ester group-containing monomer, an epoxy group-containing monomer, a fluorine-containing monomer, and combinations thereof.

2. The cathode slurry of claim 1, wherein the decomposition voltage of the lithium compound is from about 3.0 V to about 5.0 V.

3. The cathode slurry of claim 1, wherein the concentration of the lithium compound in the slurry is from about 0.005 M to 2.0 M.

4. The cathode slurry of claim 1, wherein the aqueous solvent is water.

5. The cathode slurry of claim 1, wherein the aqueous solution comprises water as the major component and a minor component; wherein the proportion of water in the aqueous solvent is from about 51% to about 100% by weight; and wherein the minor component is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert-butanol, n-butanol, acetone, dimethyl ketone, methyl ethyl ketone, ethyl acetate, isopropyl acetate, propyl acetate, butyl acetate, and combinations thereof.

6. The cathode slurry of claim 1, wherein the cathode active material is selected from the group consisting of $Li_{1+x}Ni_aMn_bCo_cAl_{(1-a-b-c)}O_2$, $LiNi_{0.33}Mn_{0.33}Co_{0.33}O_2$, $LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$, $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$, $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$, $LiNi_{0.7}Mn_{0.15}Co_{0.15}O_2$, $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$, $LiNi_{0.92}Mn_{0.04}Co_{0.04}O_2$, $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$, $LiCoO_2$, $LiNiO_2$, $LiMnO_2$, $LiMn_2O_4$, Li_2MnO_3, $LiMPO_4$, $LiNi_dMn_eO_4$, and combinations thereof, wherein $-0.2\leq x\leq 0.2$, $0\leq a<1$, $0\leq b<1$, $0\leq c<1$, $a+b+c\leq 1$, $0.1\leq d\leq 0.8$, $0.1\leq e\leq 2$, and M is selected from the group consisting of Fe, Co, Ni, Mn, Al, Mg, Zn, Ti, La, Ce, Sn, Zr, Ru, Si, Ge, or combinations thereof; and wherein the cathode active material is doped with a dopant selected from the group consisting of Fe, Ni, Mn, Al, Mg, Zn, Ti, La, Ce, Sn, Zr, Ru, Si, Ge, or combinations thereof.

7. The cathode slurry of claim 1, wherein the cathode active material comprises or is a core-shell composite comprising a core comprising a lithium transition metal oxide as claimed in claim 7 and the shell comprises a lithium transition metal oxide different to the core and is selected from the group consisting of $Li_{1+x}Ni_aMn_bCo_cAl_{(1-a-b-c)}O_2$, $LiCoO_2$, $LiNiO_2$, $LiMnO_2$, $LiMn_2O_4$, Li_2MnO_3, $LiCrO_2$, $Li_4Ti_5O_{12}$, LiV_2O_5, $LiTiS_2$, $LiMoS_2$, and combinations thereof, wherein $-0.2\leq x\leq 0.2$, $0\leq a<1$, $0\leq b<1$, $0\leq c<1$, and $a+b+c\leq 1$; and wherein each of the core and shell is independently doped with a dopant selected from the group consisting of Fe, Ni, Mn, Al, Mg, Zn, Ti, La, Ce, Sn, Zr, Ru, Si, Ge, and combinations thereof.

8. The cathode slurry of claim 1, wherein the proportion of cathode active material in the cathode slurry is from about 20% to about 70% by weight, based on the total weight of the cathode slurry.

9. The cathode slurry of claim 1, wherein the proportion of structural unit (a) within the polymeric binder is from about 15% to about 80% by mole, based on the total number of moles of monomeric units in the polymeric binder.

10. The cathode slurry of claim 1, wherein the carboxylic acid group-containing monomer is selected from the group consisting of acrylic acid, methacrylic acid, crotonic acid, 2-butyl crotonic acid, cinnamic acid, maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic anhydride, tetraconic acid, 2-ethylacrylic acid, isocrotonic acid, cis-2-pentenoic acid, trans-2-pentenoic acid, angelic acid, tiglic acid, 3,3-dimethyl acrylic acid, 3-propyl acrylic acid, trans-2-methyl-3-ethyl acrylic acid, cis-2-methyl-3-ethyl acrylic acid, 3-isopropyl acrylic acid, trans-3-methyl-3-ethyl acrylic acid, cis-3-methyl-3-ethyl acrylic acid, 2-isopropyl acrylic acid, trimethyl acrylic acid, 2-methyl-3,3-diethyl acrylic acid, 3-butyl acrylic acid, 2-butyl acrylic acid, 2-pentyl acrylic acid, 2-methyl-2-hexenoic acid, trans-3-methyl-2-hexenoic acid, 3-methyl-

3-propyl acrylic acid, 2-ethyl-3-propyl acrylic acid, 2,3-diethyl acrylic acid, 3,3-diethyl acrylic acid, 3-methyl-3-hexyl acrylic acid, 3-methyl-3-tert-butyl acrylic acid, 2-methyl-3-pentyl acrylic acid, 3-methyl-3-pentyl acrylic acid, 4-methyl-2-hexenoic acid, 4-ethyl-2-hexenoic acid, 3-methyl-2-ethyl-2-hexenoic acid, 3-tert-butyl acrylic acid, 2,3-dimethyl-3-ethyl acrylic acid, 3,3-dimethyl-2-ethyl acrylic acid, 3-methyl-3-isopropyl acrylic acid, 2-methyl-3-isopropyl acrylic acid, trans-2-octenoic acid, cis-2-octenoic acid, trans-2-decenoic acid, α-acetoxyacrylic acid, β-trans-aryloxyacrylic acid, α-chloro-β-E-methoxyacrylic acid, methyl maleic acid, dimethyl maleic acid, phenyl maleic acid, bromo maleic acid, chloromaleic acid, dichloromaleic acid, fluoromaleic acid, difluoro maleic acid, nonyl hydrogen maleate, decyl hydrogen maleate, dodecyl hydrogen maleate, octadecyl hydrogen maleate, fluoroalkyl hydrogen maleate, maleic anhydride, methyl maleic anhydride, dimethyl maleic anhydride, acrylic anhydride, methacrylic anhydride, methacrolein, methacryloyl chloride, methacryloyl fluoride, methacryloyl bromide, and combinations thereof.

11. The cathode slurry of claim 1, wherein the carboxylic acid salt group-containing monomer is selected from the group consisting of acrylic acid salt, methacrylic acid salt, crotonic acid salt, 2-butyl crotonic acid salt, cinnamic acid salt, maleic acid salt, maleic anhydride salt, fumaric acid salt, itaconic acid salt, itaconic anhydride salt, tetraconic acid salt, 2-ethylacrylic acid salt, isocrotonic acid salt, cis-2-pentenoic acid salt, trans-2-pentenoic acid salt, angelic acid salt, tiglic acid salt, 3,3-dimethyl acrylic acid salt, 3-propyl acrylic acid salt, trans-2-methyl-3-ethyl acrylic acid salt, cis-2-methyl-3-ethyl acrylic acid salt, 3-isopropyl acrylic acid salt, trans-3-methyl-3-ethyl acrylic acid salt, cis-3-methyl-3-ethyl acrylic acid salt, 2-isopropyl acrylic acid salt, trimethyl acrylic acid salt, 2-methyl-3,3-diethyl acrylic acid salt, 3-butyl acrylic acid salt, 2-butyl acrylic acid salt, 2-pentyl acrylic acid salt, 2-methyl-2-hexenoic acid salt, trans-3-methyl-2-hexenoic acid salt, 3-methyl-3-propyl acrylic acid salt, 2-ethyl-3-propyl acrylic acid salt, 2,3-diethyl acrylic acid salt, 3,3-diethyl acrylic acid salt, 3-methyl-3-hexyl acrylic acid salt, 3-methyl-3-tert-butyl acrylic acid salt, 2-methyl-3-pentyl acrylic acid salt, 3-methyl-3-pentyl acrylic acid salt, 4-methyl-2-hexenoic acid salt, 4-ethyl-2-hexenoic acid salt, 3-methyl-2-ethyl-2-hexenoic acid salt, 3-tert-butyl acrylic acid salt, 2,3-dimethyl-3-ethyl acrylic acid salt, 3,3-dimethyl-2-ethyl acrylic acid salt, 3-methyl-3-isopropyl acrylic acid salt, 2-methyl-3-isopropyl acrylic acid salt, trans-2-octenoic acid salt, cis-2-octenoic acid salt, trans-2-decenoic acid salt, α-acetoxyacrylic acid salt, β-trans-aryloxyacrylic acid salt, α-chloro-β-E-methoxyacrylic acid salt, methyl maleic acid salt, dimethyl maleic acid salt, phenyl maleic acid salt, bromo maleic acid salt, chloromaleic acid salt, dichloromaleic acid salt, fluoromaleic acid salt, difluoro maleic acid salt, and combinations thereof.

12. The cathode slurry of claim 1, wherein the sulfonic acid group-containing monomer

is selected from the group consisting of vinylsulfonic acid, methylvinylsulfonic acid, allylvinylsulfonic acid, allylsulfonic acid, methallylsulfonic acid, styrenesulfonic acid, 2-sulfoethyl methacrylic acid, 2-methylprop-2-ene-1-sulfonic acid, 2-acrylamido-2-methyl-1-propane sulfonic acid, 3-allyloxy-2-hydroxy-1-propane sulfonic acid, and combinations thereof.

13. The cathode slurry of claim 1, wherein the sulfonic acid salt group-containing monomer is selected from the group consisting of vinylsulfonic acid salt, methylvinylsulfonic acid salt, allylvinylsulfonic acid salt, allylsulfonic acid salt, methallylsulfonic acid salt, styrenesulfonic acid salt, 2-sulfoethyl methacrylic acid salt, 2-methylprop-2-ene-1-sulfonic acid salt, 2-acrylamido-2-methyl-1-propane sulfonic acid salt, 3-allyloxy-2-hydroxy-1-propane sulfonic acid salt, and combinations thereof.

14. The cathode slurry of claim 1, wherein the phosphonic acid group-containing monomer is selected from the group consisting of vinyl phosphonic acid, allyl phosphonic acid, vinyl benzyl phosphonic acid, acrylamide alkyl phosphonic acid, methacrylamide alkyl phosphonic acid, acrylamide alkyl diphosphonic acid, acryloylphosphonic acid, 2-methacryloyloxyethyl phosphonic acid, bis(2-methacryloyloxyethyl) phosphonic acid, ethylene 2-methacryloyloxyethyl phosphonic acid, ethyl-methacryloyloxyethyl phosphonic acid, and combinations thereof.

15. The cathode slurry of claim 1, wherein the phosphonic acid salt group-containing monomer is selected from the group consisting of vinyl phosphonic acid salt, salt of allyl phosphonic acid, salt of vinyl benzyl phosphonic acid, salt of acrylamide alkyl phosphonic acid, salt of methacrylamide alkyl phosphonic acid, salt of acrylamide alkyl diphosphonic acid, salt of acryloylphosphonic acid, salt of 2-methacryloyloxyethyl phosphonic acid, salt of bis(2-methacryloyloxyethyl) phosphonic acid, salt of ethylene 2-methacryloyloxyethyl phosphonic acid, salt of ethyl-methacryloyloxyethyl phosphonic acid, and combinations thereof.

16. The cathode slurry of claim 1, wherein the proportion of structural unit (b) within the polymeric binder is from about 5% to about 35% by mole, based on the total number of moles of monomeric units in the polymeric binder.

17. The cathode slurry of claim 1, wherein the amide group-containing monomer is selected from the group consisting of acrylamide, methacrylamide, N-methyl methacrylamide, N-ethyl methacrylamide, N-n-propyl methacrylamide, N-isopropyl methacrylamide, isopropyl acrylamide, N-n-butyl methacrylamide, N-isobutyl methacrylamide, N,N-dimethyl acrylamide, N,N-dimethyl methacrylamide, N,N-diethyl acrylamide, N,N-diethyl methacrylamide, N-methylol methacrylamide, N-(methoxymethyl)methacrylamide, N-

(ethoxymethyl)methacrylamide, N-(propoxymethyl)methacrylamide, N-(butoxymethyl)methacrylamide, N,N-dimethyl methacrylamide, N,N-dimethylaminopropyl methacrylamide, N,N-dimethylaminoethyl methacrylamide, N,N-dimethylol methacrylamide, diacetone methacrylamide, diacetone acrylamide, methacryloyl morpholine, N-hydroxyl methacrylamide, N-methoxymethyl acrylamide, N-methoxymethyl methacrylamide, N,N'-methylene-bis-acrylamide (MBA), N-hydroxymethyl acrylamide, and combinations thereof.

18. The cathode slurry of claim 1, wherein the proportion of structural unit (c) within the polymeric binder is from about 15% to about 75% by mole, based on the total number of moles of monomeric units in the polymeric binder.

19. The cathode slurry of claim 1, wherein the nitrile group-containing monomer is selected from the group consisting of acrylonitrile, α-halogenoacrylonitrile, α-alkylacrylonitrile, α-chloroacrylonitrile, α-bromoacrylonitrile, α-fluoroacrylonitrile, methacrylonitrile, α-ethylacrylonitrile, α-isopropylacrylonitrile, α-n-hexylacrylonitrile, α-methoxyacrylonitrile, 3-methoxyacrylonitrile, 3-ethoxyacrylonitrile, α-acetoxyacrylonitrile, α-phenylacrylonitrile, α-tolylacrylonitrile, α-(methoxyphenyl)acrylonitrile, α-(chlorophenyl)acrylonitrile, α-(cyanophenyl)acrylonitrile, vinylidene cyanide, and combinations thereof.

20. The cathode slurry of claim 1, wherein the proportion of polymeric binder within the cathode slurry is from about 0.1% to about 10% by weight, based on the total weight of the cathode slurry.

21. The cathode slurry of claim 1, further comprising a conductive agent that is selected from the group consisting of carbon, carbon black, graphite, expanded graphite, graphene, graphene nanoplatelets, carbon fibers, carbon nano-fibers, graphitized carbon flake, carbon tubes, carbon nanotubes, activated carbon, Super P, 0-dimensional KS6, 1-dimensional vapor grown carbon fibers (VGCF), mesoporous carbon, and combinations thereof.

22. The cathode slurry of claim 21, wherein the proportion of conductive agent within the cathode slurry is from about 0.5% to about 5%, based on the total weight of the cathode slurry.

23. The cathode slurry of claim 1, wherein the solid content of the cathode slurry is from 40% to 80%.

24. A cathode for a secondary battery, comprising a cathode active material, a polymeric binder, and a lithium compound, wherein the lithium compound is a compound represented by the chemical formula:

$[A^+]_aB^{a-}$

wherein the cation A+ is Li+, a is an integer from 1 to 10, and the anion B^{a-} is an oxidizable anion; wherein the polymeric binder comprises a structural unit (a) derived from a monomer selected from the group consisting of a carboxylic acid group-containing monomer, a sulfonic acid group-containing monomer, a phosphonic acid group-containing monomer, a carboxylic acid salt group-containing monomer, a sulfonic acid salt group-containing monomer, a phosphonic acid salt group-containing monomer, and combinations thereof; a structural unit (b) derived from a monomer selected from the group consisting of an amide group-containing monomer, a hydroxyl group-containing monomer, and combinations thereof; and a structural unit (c) derived from a monomer selected from the group consisting of a nitrile group-containing monomer, an ester group-containing monomer, an epoxy group-containing monomer, a fluorine-containing monomer, and combinations thereof.

25. The cathode of claim 24, wherein the decomposition voltage of the lithium compound is from about 3.0 V to about 5.0 V.

26. The cathode of claim 24, wherein the cathode active material (in the form of particles and having outer surfaces) has the lithium compound attached onto said cathode active material particle outer surfaces, and wherein the ratio of average cathode active material diameter to average lithium compound grain length is from 100:1 to 1:1.