CLAIMS

What is claimed is:

1. A method of preparing a battery cathode electrode, comprising the steps of:

1) pre-treating a cathode material in a first aqueous solution comprising water and having a pH from about 2.0 to about 8.0 to form a first suspension;

2) drying the first suspension to obtain a pre-treated cathode material;

3) dispersing the pre-treated cathode material, a conductive agent, and a binder material in a second aqueous solution to form a slurry;

4) homogenizing the slurry by a homogenizer to obtain a homogenized slurry;

5) applying the homogenized slurry on a current collector to form a coated film on the current collector; and

6) drying the coated film on the current collector to form the battery cathode electrode

wherein the cathode material is selected from the group consisting of $LiCoO_2$, $LiNiO_2$, $LiNi_xMn_yO_2$, $Li_{1+z}Ni_xMn_yCo_{1-x-y}O_2$, $LiNi_xCo_yAl_zO_2$, $LiMnO_2$, $LiCrO_2$, $LiMn_2O_4$, $LiFePO_4$, and combinations thereof, wherein each x is independently from 0.3 to 0.8; each y is independently from 0.1 to 0.45; and each z is independently from 0 to 0.2.

2. The method of claim 1, wherein the pH of the first aqueous solution is at a range from about 4 to about 7 and the first suspension is stirred for a time period from about 2 minutes to about 12 hours.

3. The method of claim 1, wherein the first aqueous solution comprises one or more acids selected from the group consisting of H_2SO_4, HNO_3, H_3PO_4, HCOOH, CH_3COOH, $H_3C_6H_5O_7$, $H_2C_2O_4$, $C_6H_{12}O_7$, $C_4H_6O_5$, and combinations thereof.

4. The method of claim 1, wherein the first suspension is dried by a double-cone vacuum dryer, a microwave dryer, or a microwave vacuum dryer.

5. The method of claim 1, wherein the first aqueous solution further comprises ethanol, isopropanol, methanol, acetone, n-propanol, t-butanol, or a combination thereof.

6. The method of claim 1, wherein the conductive agent is pre-treated in a basic solution for a time period from about 30 minutes to about 2 hours and wherein the basic solution comprises a base selected from the group consisting of H_2O_2, LiOH, NaOH, KOH, $NH_3•H_2O$, $Be(OH)_2$, $Mg(OH)_2$, $Ca(OH)_2$, Li_2CO_3, Na_2CO_3, $NaHCO_3$, K_2CO_3, $KHCO_3$, and combinations thereof.

7. The method of claim 1, wherein the conductive agent is carbon, carbon black, graphite, expanded graphite, graphene, graphene nanoplatelets, carbon fibers, carbon nano-fibers, graphitized carbon flake, carbon tubes, carbon nanotubes, activated carbon, mesoporous carbon, or a combination thereof, and wherein the conductive agent is dispersed in a third aqueous solution to form a second suspension prior to step 3), and wherein the binder material is dissolved in a fourth aqueous solution to form a resulting solution prior to step 3).

8. The method of claim 1, wherein the binder material is selected from the group consisting of styrene-butadiene rubber (SBR), carboxymethyl cellulose (CMC), polyvinylidene fluoride (PVDF), acrylonitrile copolymer, polyacrylic acid (PAA), polyacrylonitrile, poly(vinylidene fluoride)-hexafluoropropene (PVDF-HFP), latex, a salt of alginic acid, and combinations thereof,

9. The method of claim 8, wherein the salt of alginic acid comprises a cation selected from Na, Li, K, Ca, NH_4, Mg, Al, or a combination thereof.

10. The method of claim 7, wherein each of the first, second, third and fourth aqueous solutions independently is purified water, pure water, de-ionized water, distilled water, or a combination thereof.

11. The method of claim 1, wherein the slurry further comprises a dispersing agent selected from the group consisting of ethanol, isopropanol, n-propanol, t-butanol, n-butanol, lithium dodecyl sulfate, trimethylhexadecyl ammonium chloride, alcohol ethoxylate, nonylphenol ethoxylate, sodium dodecylbenzene sulfonate, sodium stearate, and combinations thereof.

12. The method of claim 1, wherein the homogenizer is a stirring mixer, a blender, a mill, an ultrasonicator, a rotor-stator homogenizer, or a high pressure homogenizer.

13. The method of claim 12, wherein the ultrasonicator is a probe-type ultrasonicator or an ultrasonic flow cell.

14. The method of claim 1, wherein the homogenized slurry is applied on the current collector using a doctor blade coater, a slot-die coater, a transfer coater, or a spray coater.

15. The method of claim 1, wherein the coated film is dried by a conveyor hot air drying oven, a conveyor resistance drying oven, a conveyor inductive drying oven, or a conveyor microwave drying oven.

16. The method of claim 1, wherein the cathode material comprises or is a core-shell composite, wherein the shell comprises a lithium transition metal oxide as claimed in claim 1, and the core comprises a lithium transition metal oxide different to the shell and is selected from the group consisting of $LiCoO_2$, $LiNi_xMn_yO_2$, $Li_{1+z}Ni_xMn_yCo_{1-x-y}O_2$, $LiNi_xCo_yAl_zO_2$, $LiMnO_2$, $LiMn_2O_4$, $LiFePO_4$, and combinations thereof; wherein each x is independently from 0.3 to 0.8; each y is independently from 0.1 to 0.45; and each z is independently from 0 to 0.2.

17. The method of claim 16, wherein each of the lithium transition metal oxides in the core and the 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.

18. The method of claim 17, wherein the diameter of the core is from about 10 μm to about 45 μm and the thickness of the shell is from about 3 μm to about 15 μm.

19. The method of claim 1, wherein the coated film is dried for a time period from about 1 minute to about 30 minutes, or from about 2 minutes to about 10 minutes at a temperature from about 45 ˚C to about 100 ˚C, or from about 55 ˚C to about 75 ˚C.