

What is claimed is:

1. A secondary battery for cycling between a charged and a discharged state, the secondary battery comprising a battery enclosure, an electrode assembly, and carrier ions within the battery enclosure, and a set of electrode constraints, wherein

(a) the electrode assembly has mutually perpendicular transverse, longitudinal and vertical axes corresponding to the x, y and z axes, respectively, of an imaginary three-dimensional cartesian coordinate system, a first longitudinal end surface and a second longitudinal end surface separated from each other in the longitudinal direction, and a lateral surface surrounding an electrode assembly longitudinal axis A_{EA} and connecting the first and second longitudinal end surfaces, the lateral surface having opposing first and second regions on opposite sides of the longitudinal axis and separated in a first direction that is orthogonal to the longitudinal axis, the electrode assembly having a maximum width W_{EA} measured in the longitudinal direction, a maximum length L_{EA} bounded by the lateral surface and measured in the transverse direction, and a maximum height H_{EA} bounded by the lateral surface and measured in the vertical direction, wherein the maximum length L_{EA} and/or maximum width W_{EA} is greater than the maximum height H_{EA} ,

(b) the electrode assembly further comprises a population of electrode structures, a population of electrode current collectors, a population of separators that are ionically permeable to the carrier ions, a population of counter-electrode structures, a population of counter-electrode collectors, and a population of unit cells wherein

(i) members of the electrode and counter-electrode structure populations are arranged in an alternating sequence in the longitudinal direction,

(ii) each member of the population of electrode structures comprises a layer of an electrode active material having a length L_E that corresponds to the Feret diameter of the electrode active material layer as measured in the transverse direction between first and second opposing transverse end surfaces of the electrode active material layer, and a height H_E that corresponds to the Feret diameter of the electrode active material layer as measured in the vertical direction between first and second opposing vertical end surfaces of the electrode active material layer, and a width W_E that corresponds to the Feret diameter of the electrode active material layer as

measured in the longitudinal direction between first and second opposing surfaces of the electrode active material layer, and each member of the population of counter-electrode structures comprises a layer of a counter-electrode active material having a length L_C that corresponds to the Feret diameter of the counter-electrode active material layer as measured in the transverse direction between first and second opposing transverse end surfaces of the counter-electrode active material layer, and a height H_C that corresponds to the Feret diameter of the counter-electrode active material layer as measured in the vertical direction between first and second opposing vertical end surfaces of the counter-electrode active material layer, and a width W_C that corresponds to the Feret diameter of the counter-electrode active material layer as measured in the longitudinal direction between first and second opposing surfaces of the counter-electrode active material layer,

(iii) each unit cell comprises a unit cell portion of a first member of the electrode current collector population, a member of the separator population that is ionically permeable to the carrier ions, a first electrode active material layer of one member of the electrode population, a unit cell portion of a first member of the counter-electrode current collector population and a first counter-electrode active material layer of one member of the counter-electrode population, wherein (aa) the first electrode active material layer is proximate a first side of the separator and the first counter-electrode material layer is proximate an opposing second side of the separator, (bb) the separator electrically isolates the first electrode active material layer from the first counter-electrode active material layer and carrier ions are primarily exchanged between the first electrode active material layer and the first counter-electrode active material layer via the separator of each such unit cell during cycling of the battery between the charged and discharged state, and (cc) within each unit cell,

a. the first vertical end surfaces of the electrode and the counter-electrode active material layers are on the same side of the electrode assembly, a 2D map of the median vertical position of the first opposing vertical end surface of the electrode active material in the X-Z plane, along the length L_E of the electrode active material layer, traces a first vertical end surface plot, E_{VP1} , a 2D map of the median vertical position of the first opposing vertical end surface of the counter-electrode active material layer in the X-Z plane, along the length L_C of the counter-electrode active material layer, traces a first vertical end surface plot, CE_{VP1} , wherein for at least 60% of the length L_C of the first counter-electrode active material layer (i) the absolute value of a separation distance, S_{Z1} , between the plots E_{VP1} and CE_{VP1} measured in the vertical direction is $1000\text{ }\mu\text{m} \geq |S_{Z1}| \geq 5\text{ }\mu\text{m}$,

and (ii) as between the first vertical end surfaces of the electrode and counter-electrode active material layers, the first vertical end surface of the counter-electrode active material layer is inwardly disposed with respect to the first vertical end surface of the electrode active material layer,

b. the second vertical end surfaces of the electrode and counter-electrode active material layer are on the same side of the electrode assembly, and oppose the first vertical end surfaces of the electrode and counter-electrode active material layers, respectively, a 2D map of the median vertical position of the second opposing vertical end surface of the electrode active material layer in the X-Z plane, along the length L_E of the electrode active material layer, traces a second vertical end surface plot, E_{VP2} , a 2D map of the median vertical position of the second opposing vertical end surface of the counter-electrode active material layer in the X-Z plane, along the length L_C of the counter-electrode active material layer, traces a second vertical end surface plot, CE_{VP2} , wherein for at least 60% of the length L_C of the counter-electrode active material layer (i) the absolute value of a separation distance, S_{Z2} , between the plots E_{VP2} and CE_{VP2} as measured in the vertical direction is $1000\text{ }\mu\text{m} \geq |S_{Z2}| \geq 5\text{ }\mu\text{m}$, and (ii) as between the second vertical end surfaces of the electrode and counter-electrode active material layers, the second vertical end surface of the counter-electrode active material layer is inwardly disposed with respect to the second vertical end surface of the electrode active material layer,

(c) the set of electrode constraints comprises a primary constraint system comprising first and second primary growth constraints and at least one primary connecting member, the first and second primary growth constraints separated from each other in the longitudinal direction, and the at least one primary connecting member connecting the first and second primary growth constraints, wherein the primary constraint system restrains growth of the electrode assembly in the longitudinal direction such that any increase in the Feret diameter of the electrode assembly in the longitudinal direction over 20 consecutive cycles of the secondary battery is less than 20%.

2. The secondary battery according to claim 1, wherein within each unit cell,

c. the first transverse end surfaces of the electrode and counter-electrode active material layers are on the same side of the electrode assembly, a 2D map of the median transverse position of the first opposing transverse end surface of the electrode active material layer in the X-Z plane, along the height H_{EA} of the electrode active material layer, traces a first transverse end

surface plot, E_{TP1} , a 2D map of the median transverse position of the first opposing transverse end surface of the counter-electrode in the X-Z plane, along the height H_C of the counter-electrode active material layer, traces a first transverse end surface plot, CE_{TP1} , wherein for at least 60% of the height H_C of the counter electrode active material layer (i) the absolute value of a separation distance, S_{X1} , between the plots E_{TP1} and CE_{TP1} measured in the transverse direction is $1000\ \mu\text{m} \geq |S_{X1}| \geq 5\ \mu\text{m}$, and (ii) as between the first transverse end surfaces of the electrode and counter-electrode active material layers, the first transverse end surface of the counter-electrode active material layer is inwardly disposed with respect to the first transverse end surface of the electrode active material layer, and

d. the second transverse end surfaces of the electrode and counter-electrode active material layers are on the same side of the electrode assembly, and oppose the first transverse end surfaces of the electrode and counter-electrode active material layers, respectively, a 2D map of the median transverse position of the second opposing transverse end surface of the electrode active material layer in the X-Z plane, along the height H_E of the electrode active material layer, traces a second transverse end surface plot, E_{TP2} , a 2D map of the median transverse position of the second opposing transverse end surface of the counter-electrode in the X-Z plane, along the height H_C of the counter-electrode active material layer, traces a second transverse end surface plot, CE_{TP2} , wherein for at least 60% of the height H_C of the counter-electrode active material layer (i) the absolute value of a separation distance, S_{X2} , between the plots E_{TP2} and CE_{TP2} measured in the transverse direction is $1000\ \mu\text{m} \geq |S_{X2}| \geq 5\ \mu\text{m}$, and (ii) as between the second transverse end surfaces of the electrode and counter-electrode active material layers, the second transverse end surface of the counter-electrode active material layer is inwardly disposed with respect to the second transverse end surface of the electrode active material layer.

3. The secondary battery according to claim 1, wherein the electrode assembly further comprises one or more carrier ion insulating material layers, each electrode current collector of the population is electrically isolated from each counter-electrode active material layer of the population, and each counter-electrode current collector of the population is electrically isolated from each electrode active material layer of the population, and within each unit cell,

the one or more carrier ion insulating material layers have an ionic conductance of carrier ions that does not exceed 10% of the ionic conductance of the separator of carrier ions during cycling of the battery, and ionically insulate at least a portion of a surface of the electrode current collector

layer from the electrolyte that is proximate to one or more of the first and second vertical end surfaces of the electrode active material layer.

4. The secondary battery according to claim 1, wherein the electrode assembly further comprises one or more carrier ion insulating material layers,

each electrode current collector of the population is electrically isolated from each counter-electrode active material layer of the population, and each counter-electrode current collector of the population is electrically isolated from each electrode active material layer of the population, and

within each unit cell,

the one or more carrier ion insulating material layers have an ionic conductance of carrier ions that does not exceed 10% of the ionic conductance of the separator of carrier ions during cycling of the battery, and ionically insulate at least a portion of a surface of the electrode current collector layer from the electrolyte that is proximate to one or more of and within a distance D_{CC} of (i) the first and second transverse end surfaces surface of the electrode active material layer.

5. The secondary battery according to claim 1, wherein:

(d) for each unit cell, (i) the first member of the electrode current collector population extends at least partially along the length L_E of the electrode active material layer in the transverse direction and comprises an electrode current collector end that extends past the first transverse end surface of the counter-electrode active material layer of each such unit cell, and (ii) the counter-electrode current collector extends at least partially along the length L_C of the counter-electrode active material layer in the transverse direction and comprises a counter-electrode current collector end that extends past the second transverse end surface of the electrode active material layer in the transverse direction of each such unit cell, and

the secondary battery further comprises at least one of:

(e)(i) an electrode busbar comprising at least one conductive segment configured to electrically connect to the population of electrode current collectors, and extending in the longitudinal direction of the electrode assembly, the conductive segment comprising a first side

having an interior surface facing the first transverse end surfaces of the counter-electrode active material layers, and an opposing second side having an exterior surface, the conductive segment optionally comprising a plurality of apertures spaced apart on along the longitudinal direction, the conductive segment of the electrode bus bar being arranged with respect to the electrode current collector ends such that the electrode current collector ends extend at least partially past a thickness of the conductive segment, to electrically connect thereto, the thickness of the conductive segment being measured between the interior and exterior surfaces, and

(e)(ii) a counter-electrode busbar comprising at least one conductive segment configured to electrically connect to the population of counter-electrode current collectors, and extending in the longitudinal direction of the electrode assembly, the conductive segment comprising a first side having an interior surface facing the second transverse end surfaces of the electrode active material layers, and an opposing second side having an exterior surface, the conductive segment optionally comprising a plurality of apertures spaced apart on along the longitudinal direction, the conductive segment of the counter-electrode bus bar being arranged with respect to the counter-electrode current collector ends such that the counter-electrode current collector ends extend at least partially past a thickness of the conductive segment, to electrically connect thereto, the thickness of the conductive segment being measured between the interior and exterior surfaces.

6. The secondary battery according to claim 5, wherein in the case of the electrode busbar (i) the conductive segment comprises a plurality of apertures spaced apart along the longitudinal direction, wherein each of the plurality of apertures are configured to allow one or more electrode current collector ends to extend at least partially therethrough to electrically connect the one or more electrode current collector ends to the electrode busbar, and wherein in the case of the counter-electrode busbar (ii) the conductive segment comprises a plurality of apertures spaced apart along the longitudinal direction, wherein each of the plurality of apertures are configured to allow one or more counter-electrode current collector ends to extend at least partially therethrough to electrically connect the one or more counter-electrode current collector ends to the counter-electrode busbar.
7. The secondary battery according to claim 1, wherein the electrode structures of the population of electrode structures comprise negative electrodes, and the counter-electrode structures of the population of counter-electrode structures comprise positive electrodes.

8. The secondary battery according to claim 1, wherein the electrode the electrode structures of the population of electrode structures comprise positive electrodes, and the counter-electrode structures of the population of counter-electrode structures comprise negative electrodes.
9. The secondary battery according to claim 1, wherein the set of electrode constraints further comprises a secondary constraint system comprising first and second secondary growth constraints separated in a second direction and connected by at least one secondary connecting member, wherein the secondary constraint system at least partially restrains growth of the electrode assembly in the second direction upon cycling of the secondary battery, the second direction being orthogonal to the longitudinal direction.
10. The secondary battery according to claim 9, wherein the first and second secondary growth constraints are separated in the vertical direction and connected by the at least one secondary connecting member, and wherein the secondary constraint system at least partially restrains growth of the electrode assembly in the vertical direction upon cycling of the secondary battery.
11. The secondary battery according to claim 9, wherein the first and second secondary growth constraints are separated in the transverse direction and connected by the at least one secondary connecting member, and wherein the secondary constraint system at least partially restrains growth of the electrode assembly in the transverse direction upon cycling of the secondary battery.
12. The secondary battery according to claim 9, wherein the electrode active material has the capacity to accept more than one mole of carrier ion per mole of electrode active material when the secondary battery is charged from the discharged state to the charged state, and wherein the at least one secondary member maintains the first and second secondary constraints in tension with each other, the at least one secondary member comprising a portion of one or more electrode current collectors of the electrode current collector population.
13. The secondary battery according to claim 9, wherein the electrode active material has the capacity to accept more than one mole of carrier ion per mole of electrode active material when the secondary battery is charged from the discharged state to the charged state, and wherein the at least one secondary member maintains the first and second secondary constraints in tension

with each other, the at least one secondary member comprising a portion of one or more counter-electrode current collectors of the counter-electrode current collector population.

14. The secondary battery according to claim 9, wherein the electrode active material has the capacity to accept more than one mole of carrier ion per mole of electrode active material when the secondary battery is charged from the discharged state to the charged state, and wherein the at least one secondary member maintains the first and second secondary constraints in tension with each other, the at least one secondary member comprising a portion of one or more electrode current collectors of the electrode current collector population, one or more counter-electrode current collectors of the counter-electrode current collector population, and one or more separators of the population of separators.
15. The secondary battery according to claim 9, wherein the at least one secondary member connecting the first and second secondary growth constraints inhibits buckling of the first and second secondary growth constraints upon cycling of the secondary battery.
16. The secondary battery according to claim 9, wherein the electrode current collector and/or counter-electrode current collector comprise attachment sections configured to secure the electrode current collector and/or counter-electrode current collector to a portion of the electrode constraint system that is configured to constrain growth of the electrode assembly in the vertical direction, and wherein the attachment sections of at least one of the electrode and counter-electrode current collectors comprise a portion of a secondary connecting member of the electrode constraint system that attaches to the first and second secondary growth constraints to at least partially restrain growth of the electrode assembly in the vertical direction, and wherein the attachment sections each comprise any one or combination of a textured surface, openings extending through the vertical ends in the longitudinal direction, grooves, protrusions, and indentations.
17. The secondary battery according to claim 9, wherein the secondary growth constraint system restrains growth of the electrode assembly in the second direction such that any increase in the Feret diameter of the electrode assembly in the second direction over 20 consecutive cycles upon repeated cycling of the secondary battery is less than 20%.

18. The secondary battery according to claim 9, wherein the secondary constraint system restrains growth of the electrode assembly in the vertical direction with a restraining force of greater than 1000 psi and a skew of less than 0.2 mm/m.
19. The secondary battery according to claim 9, wherein members of the population of unit cells of the secondary battery further comprise:
- electrically insulating and non-ionically permeable insulators between the first and second vertical surfaces of the counter-electrode active material layer and the first and second secondary growth constraints.
20. The secondary battery according to claim 1, wherein the secondary battery comprises a carrier ion insulating material layer that ionically insulates a surface of the electrode current collector layer from the electrolyte, and wherein the carrier ion insulating material comprises at least one of a ceramic, polymer, glass, adhesive, and combinations and/or composites thereof.
21. The secondary battery according to claim 1, wherein the ratio of each of L_{EA} and W_{EA} to H_{EA} is at least 2:1, respectively.
22. The secondary battery according to claim 1, wherein the electrode active material layer comprises anode active material selected from the group consisting of graphite, tin, lead, magnesium, aluminum, boron, gallium, silicon, Si/C composites, Si/graphite blends, SiOx, porous Si, intermetallic Si alloys, indium, zirconium, germanium, bismuth, cadmium, antimony, silver, zinc, arsenic, hafnium, yttrium, lithium, sodium, graphite, carbon, lithium titanate, palladium, and mixtures thereof.
23. The secondary battery according to claim 1, wherein the secondary battery comprises an insulator extending over the first and second transverse surfaces of the counter-electrode active material layer.
24. The secondary battery according to claim 1, wherein the secondary battery comprises a carrier ion insulating material comprising (i) a coating that at least partially covers surfaces adjacent vertical ends of the electrode and/or counter-electrode current collectors that extend vertically past the first and/or second vertical end surfaces of adjacent electrode and/or counter-

electrode active material layers, to ionically insulate the surfaces from electrolyte, and/or (ii) a coating that at least partially covers surfaces adjacent transverse ends of the electrode and/or counter-electrode current collectors that extend in a transverse direction past the first and/or second transverse end surfaces of adjacent electrode and/or counter-electrode active material layers, to ionically insulate the surfaces electrolyte.

25. A secondary battery for cycling between a charged and a discharged state, the secondary battery comprising a battery enclosure, an electrode assembly, and carrier ions within the battery enclosure, and a set of electrode constraints, wherein

(a) the electrode assembly has mutually perpendicular transverse, longitudinal and vertical axes corresponding to the x, y and z axes, respectively, of an imaginary three-dimensional cartesian coordinate system, a first longitudinal end surface and a second longitudinal end surface separated from each other in the longitudinal direction, and a lateral surface surrounding an electrode assembly longitudinal axis A_{EA} and connecting the first and second longitudinal end surfaces, the lateral surface having opposing first and second regions on opposite sides of the longitudinal axis and separated in a first direction that is orthogonal to the longitudinal axis, the electrode assembly having a maximum width W_{EA} measured in the longitudinal direction, a maximum length L_{EA} bounded by the lateral surface and measured in the transverse direction, and a maximum height H_{EA} bounded by the lateral surface and measured in the vertical direction, wherein the maximum length L_{EA} and/or the maximum width W_{EA} is greater than the maximum height H_{EA} ,

(b) the electrode assembly further comprises a population of electrode structures, a population of electrode current collectors, a population of separators that are ionically permeable to the carrier ions, a population of counter-electrode structures, a population of counter-electrode collectors, and a population of unit cells wherein

(i) members of the electrode and counter-electrode structure populations are arranged in an alternating sequence in the longitudinal direction,

(ii) each member of the population of electrode structures comprises a layer of an electrode active material having a length L_E that corresponds to the Feret diameter of the electrode active material layer as measured in the transverse direction between first and second opposing

transverse end surfaces of the electrode active material layer, and a height H_E that corresponds to the Feret diameter of the electrode active material layer as measured in the vertical direction between first and second opposing vertical end surfaces of the electrode active material layer, and a width W_E that corresponds to the Feret diameter of the electrode active material layer as measured in the longitudinal direction between first and second opposing surfaces of the electrode active material layer, and each member of the population of counter-electrode structures comprises a layer of a counter-electrode active material having a length L_C that corresponds to the Feret diameter of the counter-electrode active material layer as measured in the transverse direction between first and second opposing transverse end surfaces of the counter-electrode active material layer, and a height H_C that corresponds to the Feret diameter of the counter-electrode active material layer as measured in the vertical direction between first and second opposing vertical end surfaces of the counter-electrode active material layer, and a width W_C that corresponds to the Feret diameter of the counter-electrode active material layer as measured in the longitudinal direction between first and second opposing surfaces of the counter-electrode active material layer,

(iii) each unit cell comprises a unit cell portion of a first member of the electrode current collector population, a member of the separator population that is ionically permeable to the carrier ions, a first electrode active material layer of one member of the electrode population, a unit cell portion of a first member of the counter-electrode current collector population and a first counter-electrode active material layer of one member of the counter-electrode population, wherein (aa) the first electrode active material layer is proximate a first side of the separator and the first counter-electrode material layer is proximate an opposing second side of the separator, (bb) the separator electrically isolates the first electrode active material layer from the first counter-electrode active material layer and carrier ions are primarily exchanged between the first electrode active material layer and the first counter-electrode active material layer via the separator of each such unit cell during cycling of the battery between the charged and discharged state, and (cc) within each unit cell,

a. the first transverse end surfaces of the electrode and counter-electrode active material layers are on the same side of the electrode assembly, a 2D map of the median transverse position of the first opposing transverse end surface of the electrode active material layer in the X-Z plane, along the height H_{EA} of the electrode active material layer, traces a first transverse end surface plot, E_{TP1} , a 2D map of the median transverse position of the first opposing transverse

end surface of the counter-electrode in the X-Z plane, along the height H_C of the counter-electrode active material layer, traces a first transverse end surface plot, CE_{TP1} , wherein for at least 60% of the height H_C of the counter electrode active material layer (i) the absolute value of a separation distance, S_{X1} , between the plots E_{TP1} and CE_{TP1} measured in the transverse direction is $1000\text{ }\mu\text{m} \geq |S_{X1}| \geq 5\text{ }\mu\text{m}$, and (ii) as between the first transverse end surfaces of the electrode and counter-electrode active material layers, the first transverse end surface of the counter-electrode active material layer is inwardly disposed with respect to the first transverse end surface of the electrode active material layer,

b. the second transverse end surfaces of the electrode and counter-electrode active material layers are on the same side of the electrode assembly, and oppose the first transverse end surfaces of the electrode and counter-electrode active material layers, respectively, a 2D map of the median transverse position of the second opposing transverse end surface of the electrode active material layer in the X-Z plane, along the height H_E of the electrode active material layer, traces a second transverse end surface plot, E_{TP2} , a 2D map of the median transverse position of the second opposing transverse end surface of the counter-electrode in the X-Z plane, along the height H_C of the counter-electrode active material layer, traces a second transverse end surface plot, CE_{TP2} , wherein for at least 60% of the height H_C of the counter-electrode active material layer (i) the absolute value of a separation distance, S_{X2} , between the plots E_{TP2} and CE_{TP2} measured in the transverse direction is $1000\text{ }\mu\text{m} \geq |S_{X2}| \geq 5\text{ }\mu\text{m}$, and (ii) as between the second transverse end surfaces of the electrode and counter-electrode active material layers, the second transverse end surface of the counter-electrode active material layer is inwardly disposed with respect to the second transverse end surface of the electrode active material layer,

(c) the set of electrode constraints comprises a primary constraint system comprising first and second primary growth constraints and at least one primary connecting member, the first and second primary growth constraints separated from each other in the longitudinal direction, and the at least one primary connecting member connecting the first and second primary growth constraints, wherein the primary constraint system restrains growth of the electrode assembly in the longitudinal direction such that any increase in the Feret diameter of the electrode assembly in the longitudinal direction over 20 consecutive cycles of the secondary battery is less than 20%.

26. The secondary battery according to claim 25, wherein

the electrode assembly further comprises one or more carrier ion insulating material layers,

each electrode current collector of the population is electrically isolated from each counter-electrode active material layer of the population, and each counter-electrode current collector of the population is electrically isolated from each electrode active material layer of the population, and

within each unit cell,

the one or more carrier ion insulating material layers have an ionic conductance of carrier ions that does not exceed 10% of the ionic conductance of the separator of carrier ions during cycling of the battery, and ionically insulate at least a portion of a surface of the electrode current collector layer from the electrolyte that is proximate to one or more of the first and second vertical end surfaces of the electrode active material layer.

27. The secondary battery according to claim 25, wherein

the electrode assembly further comprises one or more carrier ion insulating material layers,

each electrode current collector of the population is electrically isolated from each counter-electrode active material layer of the population, and each counter-electrode current collector of the population is electrically isolated from each electrode active material layer of the population, and

within each unit cell,

the one or more carrier ion insulating material layers have an ionic conductance of carrier ions that does not exceed 10% of the ionic conductance of the separator of carrier ions during cycling of the battery, and ionically insulate at least a portion of a surface of the electrode current collector layer from the electrolyte that is proximate to one or more of and within a distance D_{cc} of (i) the first and second transverse end surfaces surface of the electrode active material layer.

28. The secondary battery according to claim 25, wherein:

(d) for each unit cell, (i) the first member of the electrode current collector population extends at least partially along the length L_E of the electrode active material layer in the transverse direction and comprises an electrode current collector end that extends past the first transverse end surface of the counter-electrode active material layer of each such unit cell, and (ii) the counter-electrode current collector extends at least partially along the length L_c of the counter-electrode active material layer in the transverse direction and comprises a counter-electrode current collector end that extends past the second transverse end surface of the electrode active material layer in the transverse direction of each such unit cell, and

the secondary battery further comprises at least one of:

(e) (i) an electrode busbar comprising at least one conductive segment configured to electrically connect to the population of electrode current collectors, and extending in the longitudinal direction of the electrode assembly, the conductive segment comprising a first side having an interior surface facing the first transverse end surfaces of the counter-electrode active material layers, and an opposing second side having an exterior surface, the conductive segment optionally comprising a plurality of apertures spaced apart on along the longitudinal direction, the conductive segment of the electrode bus bar being arranged with respect to the electrode current collector ends such that the electrode current collector ends extend at least partially past a thickness of the conductive segment, to electrically connect thereto, the thickness of the conductive segment being measured between the interior and exterior surfaces, and

(e) (ii) a counter-electrode busbar comprising at least one conductive segment configured to electrically connect to the population of counter-electrode current collectors, and extending in the longitudinal direction of the electrode assembly, the conductive segment comprising a first side having an interior surface facing the second transverse end surfaces of the electrode active material layers, and an opposing second side having an exterior surface, the conductive segment optionally comprising a plurality of apertures spaced apart on along the longitudinal direction, the conductive segment of the counter-electrode bus bar being arranged with respect to the counter-electrode current collector ends such that the counter-electrode current collector ends extend at least partially past a thickness of the conductive segment, to electrically connect thereto, the thickness of the conductive segment being measured between the interior and exterior surfaces.

29. The secondary battery according to claim 28, wherein in the case of the electrode busbar (i) the conductive segment comprises a plurality of apertures spaced apart along the longitudinal direction, wherein each of the plurality of apertures are configured to allow one or more electrode current collector ends to extend at least partially therethrough to electrically connect the one or more electrode current collector ends to the electrode busbar, and wherein in the case of the counter-electrode busbar (ii) the conductive segment comprises a plurality of apertures spaced apart along the longitudinal direction, wherein each of the plurality of apertures are configured to allow one or more counter-electrode current collector ends to extend at least partially therethrough to electrically connect the one or more counter-electrode current collector ends to the counter-electrode busbar.
30. The secondary battery according to claim 25, wherein the set of electrode constraints further comprises a secondary constraint system comprising first and second secondary growth constraints separated in a second direction and connected by at least one secondary connecting member, wherein the secondary constraint system at least partially restrains growth of the electrode assembly in the second direction upon cycling of the secondary battery, the second direction being orthogonal to the longitudinal direction.