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, carrier ions, a non-aqueous liquid electrolyte within the battery enclosure, and a set of electrode constraints, wherein

the electrode assembly has mutually perpendicular longitudinal, transverse, and vertical axes, 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, the ratio of each of L_{EA} and W_{EA} to H_{EA} being at least 2:1, respectively,

the electrode assembly further comprises a population of electrode structures, a population of counter-electrode structures, and an electrically insulating microporous separator material electrically separating members of the electrode and counter-electrode populations, members of the electrode and counter-electrode structure populations being arranged in an alternating sequence in the longitudinal direction, the electrode and counter-electrode populations each comprising at least N members wherein N is at least 5, each member of the electrode population has a bottom, a top, and a longitudinal axis A_E extending from the bottom to the top thereof and in a direction generally perpendicular to the direction in which the alternating sequence of electrode structures and counter-electrode structures progresses, each member of the electrode population having a length L_E measured along the longitudinal axis A_E of the electrode, a width W_E measured in the direction in which the alternating sequence of electrode structures and counter-electrode structures progresses, a height H_E measured in a

direction that is perpendicular to each of the directions of measurement of the length L_E and the width W_E, wherein the ratio of L_E to each of W_E and H_E is at least 5:1, respectively for each member of the electrode population,

each member of the population of electrode structures comprises a layer of an electrode active material and each member of the population of counter-electrode structures comprises a layer of a counter-electrode active material, 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 a discharged state to a charged state,

the set of electrode constraints comprises a primary constraint system and a secondary constraint system, the primary constraint system comprising first and second primary growth constraints separated in the longitudinal direction and at least one primary connecting member connecting the first and second primary growth constraints, the secondary constraint system comprising first and second secondary growth constraints separated in a second direction that is orthogonal to the longitudinal direction and at least one secondary connecting member connecting the first and second secondary growth constraints, wherein at least one of the secondary connecting member(s) connects the first and second secondary growth restraints at a location along the longitudinal axis that is between the first and second longitudinal end surfaces of the electrode assembly, the secondary constraint system at least partially restrains growth of the electrode assembly in the second direction upon cycling of the secondary battery, 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%, and

the charged state is at least 75% of a rated capacity of the secondary battery, and the discharged state is less than 25% of the rated capacity of the secondary battery.

2. The secondary battery of claim 1, wherein the at least one primary connecting member comprises first and second primary connecting members that are separated from each other in the first direction and connect the first and second primary growth constraints.

3. The secondary battery of claim 1, wherein the first and second directions are the same direction.

4. The secondary battery of claim 1, 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%.

5. The secondary battery of claim 1, wherein a surface area of a projection of the electrode assembly in a plane orthogonal to a stacking direction, is smaller than the surface areas of projections of the electrode assembly onto other orthogonal planes.

6. The secondary battery of claim 1, wherein at least a portion of the primary growth constraint system is pre-tensioned to exert a compressive force on at least a portion of the electrode assembly in the longitudinal direction, prior to cycling of the secondary battery between charged and discharged states.

7. The secondary battery of claim 2, wherein the at least one secondary connecting member comprises first and second secondary connecting members that are separated from each other in the second direction and connect the first and second secondary growth constraints, the first and second directions are the same direction, the first primary connecting member is the first secondary growth constraint, the second primary connecting member is the second secondary growth constraint, and the first primary growth constraint or the second primary growth constraint is the first secondary connecting member.

8. The secondary battery of claim 1, wherein at least one of the first and second primary growth constraints is interior to the first and second longitudinal end surfaces of the electrode assembly along the longitudinal axis.

9. The secondary battery of claim 1, wherein at least one of the first and second primary growth constraints comprises at least a portion of one or more of the electrode and counter electrode structures.

10. The secondary battery of claim 1, wherein at least one of the first and second primary growth constraints comprises a portion of at least one of an electrode backbone structure and a counter-electrode backbone structure.

11. The secondary battery of claim 1, wherein at least one of the first and second primary growth constraints comprises a portion of one or more of an electrode current collector and a counter-electrode current collector.

12. The secondary battery of claim 1, wherein the secondary constraint system restrains growth of the electrode assembly in the second direction with a restraining force of greater than 1000 psi and a skew of less than 0.2 mm/m.

13. The secondary battery of claim 1 wherein the secondary growth constraint restrains growth of the electrode assembly in the second direction with less than 1% displacement at less than or equal to 10,000 psi and a skew of less than 0.2 mm/m.

14. The secondary battery of claim 1 wherein members of the population of counter-electrode structures comprise a top adjacent to the first secondary growth constraint, a bottom adjacent to the second secondary growth constraint, a vertical axis A_{CES} parallel to and in the vertical direction extending from the top to the bottom, a lateral electrode surface surrounding the vertical axis A_{CES} and connecting the top and the bottom, the lateral electrode surface having opposing first and second regions on opposite sides of the vertical axis and separated in a first direction that is orthogonal to the vertical axis, a length L_{CES}, a width W_{CES}, and a height H_{CES}, the length L_{CES} being bounded by the lateral electrode surface and measured in the transverse direction, the width W_{CES} being bounded by the lateral electrode surface and measured in the

longitudinal direction, and the height H_{CES} being measured in the direction of the vertical axis A_{CES} from the top to the bottom, wherein

the first and second secondary growth constraints each comprise an inner surface and an opposing outer surface, the inner surface and the outer surface of each are substantially co-planar and the distance between the inner surface and the opposing outer surface of each of the first and second secondary growth constraints defines a height of each that is measured in the vertical direction from the inner surface to the outer surface of each, the inner surfaces of each being affixed to the top and bottom of the population of counter-electrode structures.

15. The secondary battery of claim 1, wherein members of the population of electrode structures comprise a top adjacent to the first secondary growth constraint, a bottom adjacent to the second secondary growth constraint, a vertical axis A_Es parallel to and in the vertical direction extending from the top to the bottom, a lateral electrode surface surrounding the vertical axis A_Es and connecting the top and the bottom, the lateral electrode surface having opposing first and second regions on opposite sides of the vertical axis and separated in a first direction that is orthogonal to the vertical axis, a length L_Es, a width W_Es, and a height H_Es, the length L_Es being bounded by the lateral electrode surface and measured in the transverse direction, the width W_Es being bounded by the lateral electrode surface and measured in the longitudinal direction, and the height H_Es being measured in the direction of the vertical axis A_Es from the top to the bottom, wherein

the first and second secondary growth constraints each comprise an inner surface and an opposing outer surface, the inner surface and the outer surface of each are substantially co-planar and the distance between the inner surface and the opposing outer surface of each of the first and second secondary growth constraints defines a height of each that is measured in the vertical direction from the inner surface to the outer surface of each, the inner surfaces of each being affixed to the top and bottom of the population of electrode structures.

16. The secondary battery of claim 1, wherein the electrically insulating microporous separator material comprises a particulate material and a binder, has a void fraction of at least 20 vol.%, and is permeated by the non-aqueous liquid electrolyte.

17. The secondary battery of claim 1, wherein the carrier ions are selected from the group consisting of lithium, potassium, sodium, calcium, and magnesium.

18. The secondary battery of claim 1, wherein the non-aqueous liquid electrolyte comprises a lithium salt dissolved in an organic solvent.

19. The secondary battery of claim 1, wherein the first and second secondary growth constraints each comprise a thickness that is less than 20% of the electrode or counter-electrode height.

20. The secondary battery of claim 1 wherein the set of electrode constraints inhibits expansion of the electrode active material layers in the vertical direction upon insertion of the carrier ions into the electrode active material as measured by scanning electron microscopy (SEM).

21. The secondary battery of claim 1, wherein the surface area of the first and second longitudinal end surfaces is less than 15% of the surface area of the electrode assembly.

22. The secondary battery of claim 1, wherein the constraint and enclosure have a combined volume that is less than 30% of the volume enclosed by the battery enclosure.

23. The secondary battery of claim 1 wherein the electrode assembly comprises at least 10 electrode structures and at least 10 counter-electrode structures.

24. The secondary battery of claim 1, wherein the first and second primary growth constraints exert a pressure on the first and second longitudinal end surfaces that exceeds the pressure maintained on the electrode assembly in each of two

directions that are mutually perpendicular and perpendicular to a stacking direction by factor of at least 3.

25. The secondary battery of claim 1, wherein portions of the secondary growth constraint system that are external to the electrode assembly occupy no more than 40% of the total combined volume of the electrode assembly and external portions of the secondary growth constraint system.

26. The secondary battery of claim 1, wherein the first and second primary growth constraints deflect upon repeated cycling of the secondary battery between charged and discharged states according to the following formula:

$$\delta = 60wL^4/Eh^3$$

wherein w is total distributed load applied to the first and second primary growth constraints upon repeated cycling of the secondary battery between charged and discharged states, L is the distance between first and second primary connecting members in the vertical direction, E is the elastic modulus of the first and second primary growth constraints, and h is the thickness of the first and second primary growth constraints.

27. The secondary battery of claim 1, wherein the first and second secondary growth constraints deflect upon repeated cycling of the secondary battery between charged and discharged states according to the following formula

$$\delta = 60wy^4/Et^3$$

wherein w is the total distributed load applied on the first and second secondary growth constraints upon repeated cycling of the secondary battery between charged and discharged states, y is the distance between the first and second secondary connecting members in the longitudinal direction, E is the elastic modulus of the first and second secondary growth constraints, and t is the thickness of the first and second secondary growth constraints.

28. The secondary battery of claim 1, wherein a stress on the first and second primary growth constraints upon repeated cycling of the secondary battery between charged and discharged states is as follows:

$$\sigma = 3wL^2/4h^2$$

wherein w is total distributed load applied on the first and second primary growth constraints upon repeated cycling of the secondary battery between charged and discharged states, L is the distance between first and second primary connecting members in the vertical direction, and h is the thickness of the first and second primary growth constraints.

29. The secondary battery of claim 1, wherein a tensile stress on the first and second primary connecting members is as follows:

$$\sigma = PL/2t$$

wherein P is pressure applied due to the first and second primary growth constraints upon repeated cycling of the secondary battery between charged and discharged states, L is the distance between the first and second primary connecting members along the vertical direction, and t is the thickness of the first and second primary connecting members in the vertical direction.

30. The secondary battery of claim 1, wherein a tensile stress on the first and second secondary connecting members is as follows:

$$\sigma = Py/2h,$$

wherein P is the pressure applied on the first and second secondary growth constraints upon repeated cycling of the secondary battery, y is the distance between the first and second secondary connecting members along the longitudinal direction, and h is the thickness of the first and second secondary connecting members in the longitudinal direction.

31. The secondary battery as in any preceding claim, wherein the at least one secondary connecting member comprises at least a portion of one or more of the electrode and counter electrode structures.

32. The secondary battery as in any preceding claim, wherein the at least one secondary connecting member comprises a portion of at least one of an electrode backbone structure and a counter-electrode backbone structure.

33. The secondary battery as in any preceding claim, wherein the at least one secondary connecting member comprises a portion of one or more of an electrode current collector and a counter-electrode current collector.

34. The secondary battery as in any preceding claim, wherein the at least one primary connecting member is one or more of the first secondary growth constraint and the second secondary growth constraint.