

CLAIMS

What is claimed is:

1. An aluminum-air battery unit comprising:
 - at least one aluminum-air electrochemical cell comprising a rectangular aluminum anode, at least one corresponding air cathode, and alkaline electrolyte,
 - a frame configured to mechanically support the anode of the cell, and
 - a housing configured to support mechanically the frame and the at least one air cathode and to sealably hold the electrolyte within the housing and in fluid communication with openings in the housing;
 - wherein the frame comprises a protective strap configured to protect edges of the rectangular anode against corrosion by the electrolyte during operation, and
 - wherein the frame has an external trapezoid shape that is configured to press the protective strap against the edges of the rectangular anode upon insertion of the frame with the anode into the housing.
2. The aluminum-air battery unit of claim 1, wherein the external trapezoid shape of the frame is configured to fit into a trapezoid cavity in the housing.
3. The aluminum-air battery unit of claim 1, wherein the housing is configured to receive the frame by a click connection to the external trapezoid shape of the frame which is configured to apply the pressure on the protective strap against the edges of the rectangular anode.
4. The aluminum-air battery unit of any one of claims 1-3, wherein the housing comprises at least two parts configured to enclose the frame snugly.
5. The aluminum-air battery unit of any one of claims 1-4, wherein the housing and the frame are configured to press the protective strap against all four edges of the rectangular anode upon insertion of the frame with the anode into the housing.
6. The aluminum-air battery unit of any one of claims 1-5, wherein the at least one air cathode comprises a current collector that is a rectangular planar sideways-bent strap.
7. The aluminum-air battery unit of claim 6, wherein the rectangular planar sideways-bent strap is fixated at a contact region of the respective cathode.
8. The aluminum-air battery unit of claim 7, wherein the contact region is central with respect to a side of the respective cathode and the cathode is symmetric along a central axis thereof.

9. The aluminum-air battery unit of any one of claims 1-8, further comprising at least one spacer configured to mechanically prevent contact between the anode and cathode upon emptying the electrolyte from the unit.
10. The aluminum-air battery unit of claim 9, wherein the comprising at least one spacer comprises at least one rod connected to the housing in a plane between the anode and the at least one cathode.
11. The aluminum-air battery unit of any one of claims 1-10, wherein a part of the anode extends outside the frame, is sealed from contact with the electrolyte in the cell, and is used as an anode connector.
12. The aluminum-air battery unit of claim 11, wherein the part of the anode extending outside the frame is a triangular corner of the rectangular anode, and the frame comprises a seal configured to prevent electrolyte penetration to the anode part during consumption of anode material in operation.
13. The aluminum-air battery unit of claim 12, wherein the seal has a width which is at least half a thickness of the anode.
14. The aluminum-air battery unit of any one of claims 1-10, further comprising a stud attached to the anode and is used as an anode connector.
15. The aluminum-air battery unit of claim 14, wherein the frame further comprises a seal configured to prevent electrolyte penetration to the stud during consumption of anode material in operation.
16. The aluminum-air battery unit of claim 15, wherein the seal has a width which is at least half a thickness of the anode.
17. The aluminum-air battery unit of any one of claims 14-16, wherein the stud is tightly secured to the housing, to yield a force pressing the anode against the protective strap.
18. The aluminum-air battery unit of any one of claims 14-17, wherein the stud is tightly secured to the housing, to further secure an electrical connection thereof to the anode.
19. The aluminum-air battery unit of any one of claims 1-18, wherein the frame further comprises a plurality of elastic elements configured to be pressed against the housing upon insertion of the frame thereto, and enhance a contact of the protective strap to the edges of the anode.

20. The aluminum-air battery unit of any one of claims 1-19, further comprising at least one grid configured to mechanically support an adjacent one of the at least one air cathode of the unit and support airways thereto.
21. An aluminum-air battery stack comprising a plurality of the aluminum-air battery units of claim 20, wherein the at least one air cathode comprises two air cathodes placed on both sides of the respective anode in each cell and wherein each battery unit comprises a single grid configured to mechanically support two adjacent air cathodes of corresponding two adjacent units of the stack and support airways thereto
22. The aluminum-air battery unit of any one of claims 1-19, wherein the at least one air cathode comprises two air cathodes placed on both sides of the respective anode in each cell.
23. The aluminum-air battery unit of claim 22, further comprising two grids adjacent to and configured to mechanically support the corresponding two air cathodes and support airways thereto.
24. The aluminum-air battery unit of claim 23, wherein each grid comprises a network having nodal spacers.
25. An aluminum-air battery stack comprising a plurality of the aluminum-air battery units of claim 24, wherein the nodal spacers of each grid contact an adjacent grid of an adjacent battery unit to form rectangular supports to the cathodes and rectangular supports to the airways.
26. The aluminum-air battery unit of claim 23, wherein each grid comprises a plurality of strips in a direction of the airways, and wherein the strips are interconnected by a plurality of connecting elements.
27. An aluminum-air battery stack comprising a plurality of the aluminum-air battery units of claim 26, wherein the connecting elements of each grid contact an adjacent air cathode of an adjacent battery unit to form rectangular supports to the cathodes and U-shaped supports to the airways.
28. The aluminum-air battery unit of claim 23, wherein each grid comprises a plurality of undulating strips in a direction of the airways and in a direction perpendicular thereto.
29. An aluminum-air battery stack comprising a plurality of the aluminum-air battery units of claim 28, wherein the undulating strips of each grid in each direction complement each other with the corresponding undulating strips of an adjacent grid of an adjacent battery unit to form rectangular supports to the cathodes and L-shaped supports to the airways.

30. The aluminum-air battery unit of any one of claims 20, 22-24, 26 and 28, wherein the housing further comprises air passages in fluid communication with the airways supported by the respective at least one grid.
31. An aluminum-air battery stack of any one of claims 21, 25 and 27, wherein the unit housings further comprise sealed air passages in fluid communication with the airways supported by the grids.
32. An aluminum-air battery stack comprising a plurality of the aluminum-air battery units of any one of claims 1-20, 22-24, 26, 28 and 30, attached to each other with the corresponding electrochemical cells electrically serially connected and the electrolyte openings sealably attached to each other.
33. The aluminum-air battery stack of any one of claims 21, 25, 27 and 31, further configured to maintain the sealed attachment of the electrolyte openings and of the aluminum-air battery units upon removal of at least one frame with the corresponding anode from at least one corresponding housing of a corresponding one of the units.
34. The aluminum-air battery stack of claim 32 or 33, wherein the sealing is maintained along directions perpendicular to a plane of the at least one removed frame and anode.
35. A method comprising:
- configuring an aluminum-air battery unit, comprising an aluminum-air electrochemical cell comprising a rectangular aluminum anode, at least one air cathode and alkaline electrolyte, to have a frame mechanically supporting the anode of the cell,
 - supporting mechanically the frame and the at least one air cathode in a housing configured to sealably hold the electrolyte therewithin in fluid communication with openings in the housing for receiving delivered electrolyte,
 - placing a protective strap between an inner perimeter of the frame and an outer perimeter of the anode, configured to protect edges of the rectangular anode against corrosion by the electrolyte during operation, and
 - forming the frame to have an external trapezoid shape, that is configured to press the protective strap against the edges of the rectangular anode upon insertion of the frame with the anode into the housing.

36. The method of claim 35, further comprising configuring the housing and the frame to press the protective strap against all four edges of the rectangular anode upon insertion of the frame with the anode into the housing
37. The method of claim 35 or 36, further comprising shaping a current collector of the at least one air cathode as a rectangular planar sideways-bent strap.
38. The method of any one of claims 35-37, further comprising sealing a part of the rectangular anode from contact with the electrolyte in the cell and connecting the sealed part to an anode connector.
39. The method of claim 38, further comprising selecting the sealed part of the rectangular anode as a triangular corner of the rectangular anode, and preventing electrolyte penetration to the anode part during consumption of anode material in operation.
40. The method of any one of claims 35-37, further comprising attaching a stud to the anode, using the stud as an anode connector and sealing a portion surrounding the stud to prevent electrolyte penetration to the stud during consumption of anode material in operation.
41. The aluminum-air battery unit of claim 40, further comprising tightly securing the stud to the housing, to yield a force pressing the anode against the protective strap and to secure an electrical connection thereof to the anode.
42. The method of any one of claims 35-41, further comprising enhancing a contact of the protective strap to the edges of the anode by pressing a plurality of elastic elements against the housing upon insertion of the frame thereto.
43. The method of any one of claims 35-42, further comprising mechanically preventing contact between the anode and the at least one air cathode upon emptying the electrolyte from the unit.
44. The method of any one of claims 35-43, further comprising mechanically supporting the at least one air cathode by a grid which further supports airways to the at least one air cathode, which are in fluid communication with air passages in the housing.
45. The method of any one of claims 35-43, further comprising assembling multiple aluminum-air battery units to form an aluminum-air battery stack having the corresponding electrochemical cells electrically serially connected and the electrolyte openings sealably attached to each other.
46. The method of claim 44, further comprising assembling multiple aluminum-air battery units to form an aluminum-air battery stack having the corresponding electrochemical cells electrically serially connected and the electrolyte openings sealably attached to each other, wherein each

cell comprises two air cathodes on either side of the respective anode, and optimizing a geometrical configuration of the grid, set between adjacent air cathodes of adjacent cells, to minimize resistance to air flow through the airways while maintaining a required level of support of the air cathodes.