Claims

1. A method of recovering lithium or sodium from an active material of a lithium or sodium ion battery, respectively, the method comprising:

(a) providing an active material comprising lithium or sodium ions;

(b) adding the active material to a redox mediator solution that comprises a solvent and a redox mediator to form a redox solution comprising lithium or sodium ions in a first tank;

(c) moving the redox solution from the first tank to a redox flow cell comprising a cathode compartment, having a cathode electrode, and an anode compartment, having an anode electrode, separated by an ion selective membrane, where the cathode electrode and anode electrode are attached to a power supply and

the redox solution is subjected to an electrochemical reaction on the anode electrode, where the electrochemical reaction on the anode:

regenerates the redox mediator, which is then returned to the first tank; and enables transport of the lithium or sodium ions through the ion selective membrane into the cathode compartment, which comprises an aqueous catholyte solution as that is obtained from a second tank comprising said aqueous catholyte solution;

(d) capturing the lithium or sodium ions in the cathode compartment through an electrochemical reaction on the cathode electrode as LiOH or NaOH and transferring the resulting aqueous LiOH or NaOH catholyte solution to a second tank, wherein:

steps (c) and (d) can be repeated until the active material is consumed.

2. The method according to Claim 1, wherein active material is a cathodic and/or anodic active material.

3. The method according to Claim 2, wherein the cathodic active material is still attached to a cathode electrode of a dismantled sodium- or lithium-ion battery or is provided free from the cathode electrode.

4. The method according to Claim 2 or Claim 3, wherein the cathodic active material is selected from one or more of $NaFePO_4$, $NaCoO_2$, more particularly, Li_xFePO_4, $Li_xNiCoMnO_2$, Li_xCoO_2, Li_xFePO_4, $Li_xNi0_{0.33}Co_{0.33}Al_{0.33}O_2$, $Li_xMn_2O_4$, $Li_xNi_{0.5}Mn_{1.5}O_4$, and Li_xCoO_2., where $0 < x \leq 1$.

5. The method according to Claim 4, wherein the cathodic active material is Li_xFePO_4.

6. The method according to any one of the preceding claims, wherein the redox mediator is selected from one or more of the group consisting of ferricyanide ($M_3Fe(CN)_6$), ferrocyanide ($M_4Fe(CN)_6$), ferrocene ($C_{10}H_{10}Fe$) and derivatives thereof, iodide (MI) and bromide (MBr), where in each case M is independently selected from the group consisting of Li, Na, K and NH_4.

7. The method according to Claim 6, wherein the redox mediator is selected from one or more of the group consisting of ferricyanide ($M_3Fe(CN)_6$), ferrocyanide ($M_4Fe(CN)_6$), iodide (MI), and bromide (MBr), where in each case M is independently selected from the group consisting of Li, Na, K and NH_4.

8. The method according to Claim 7, wherein the derivative of ferrocene is di(ethylsulfonic lithium) ferrocene ($C_{14}H_{16}FeS_2O_6Li_2$).

9. The method according to any one of Claims 6 to 8, wherein the total concentration of the redox mediator present in the solvent is from 0.05 M to 1.5 M, such as 0.2 M.

10. The method according to any one of Claims 2 to 9, wherein the solvent is pure water.

11. The method according to any one of the preceding claims, wherein the aqueous catholyte solution is initially selected from one of water, water comprising oxygen, water comprising air, water comprising oxygen and CO_2, or water comprising air and CO_2.

12. The method according to any one of the preceding claims, wherein after steps (b) and (c) have been completed, the aqueous catholyte solution is an aqueous LiOH solution, an aqueous LiOH solution comprising oxygen, an aqueous LiOH solution comprising air, an aqueous LiOH solution comprising oxygen and CO_2 with Li_2CO_3 precipitate, or an aqueous LiOH solution comprising air and CO_2 with Li_2CO_3 precipitate.

13. The method according to any one of Claims 2 to 12, wherein the anodic active material is still attached to an anode electrode of a dismantled lithium-ion battery or is provided free from the anode electrode.

14. The method according to any one of Claims 2 to 13, wherein the anode active material is selected from one or more of $Li_4Ti_5O_{12}$, Graphite, Silicon, Hard carbon.