Energy Materials

Recent advances in porous multimetallic alloy-based anodes for rechargeable alkali metal-ion batteries

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Supplementary Table 1. Comparative reviews of transition metal Alloy anodes for lithium-ion (LIBs), sodium-ion (SIBs) and potassium-ion batteries (PIBs), metal-organic framework (MOF)

Titles	Focus	Refs.
Porous multi-transition-metal alloy anodes for rechargeable alkali metal-ions batteries	This review focuses on the amazing performance of porous multi transition metal alloy (PMTMA) anodes, including Sn-, Mn-, Mo-, Co-, V and Fe-based alloys, for high-energy LIBs, SIBs and PIBs, besides the fundamental and mechanism, parameters of indicator and engineering methods including lithium (Li), sodium (Na), and potassium (K))	This work
Al-based materials for advanced lithium rechargeable batteries:	This reviewed the nanostructural design of Al powder, Al/C composite, Al_2O_3, AlN, AlF_3 and Al alloys (i.e., AlCu, AlFe, and AlSiFe) anodes for LIB, lithium-metal and lithium dual-ion	[1]

recent progress and prospects	batteries.	
Microstructure engineered silicon alloy anodes for LIBs: advances and challenges	This presented the engineering (i.e., high energy ball milling, magnetron sputtering, pulsed laser deposition and electron beam evaporation) of Si alloy anodes (i.e., SiGe, NiSi, TiSi, FeSi, ZnSi MgSi, SiGeCu) for improved performance of LIBs.	[2]
Metal sulfide-based PIB anodes: storage mechanisms and synthesis strategies	This reported the different synthesis methods (i.e., template, hydro/solvothermal, solid-phase chemical, electrospinning, ion-exchange) of 2D metal sulfide (VS_4,) composites (Mo_2S/PC, SnS_2@C, CoS_x@CNT, NiS_2@C@C, InS_3/C and Cu_2S/NC) and binary metal sulfides (Ni-Co-PBA@GO, CoS@SnS, VS_4/SnS@C, $BiSbS_x$) anodes for enhanced potassium-ion batteries (PIBs) was summarized.	[3]
Metal-organic framework-derived transition metal sulfides and their composites for alkali-ion batteries: a review	This discussed the sulfurization strategies of MOF-derived metal sulfides (i.e., ZnS, MoS_2, $Fe_{1-x}S$, MnS, CoS_2, SnS_2, Ga_2S_3, and Bi_2S_3), binary metal alloys (Zn-Co-S, MoS_2-Co_3S_4,) and their composites (i.e., ZnS/C, FeS_2/RGO, S/CoS_2-NC, ZnCoS@NC, FeS@MnS/C S@ZnS-FeS@NC, Bi_2S_3@Co_9S_8/NC, MnS/MoS_2/C, and Co_9S_8@N-C@MoS_2) as high-performance anodes for LIBs, SIBs and PIBs.	[4]
Sn-, Sb- and Bi-based anodes for PIB	This presented the synthesis methods for the preparation of Sn-based (Sn-C, Sn_4P_3/C,	[5]

	CoSn@C), Sb-based (Sb/C, $Sb/Sb_2O_4/Fe_3C$, $Sb/Na\text{-}Ti_3C_2T_x$, and MoS/Sb/N-doped G) and Bi-based (Bi@N-doped C, and CuBi) anodes for the development of PIBs.	
Review of room-temperature liquid metals for advanced metal anodes in rechargeable batteries	This presented the application of Ga-based liquid alloys (Ga with In, Sn, Zn, Cu, Li, Mg, Al, Au, Ag, and Ni) and liquid Na-K alloys anodes for rechargeable Li-, Na-, K-, Zn-, and Mg-ions batteries.	[6]
SiO_2-based LIB anode materials: a brief review	This discussed the utilization of SiO_2-composites (i.e., Li_xSi/Li_2O and SiO_2@C) and binary oxides alloy (SiO_2@TiO_2) as impressive anode for improved LIB performance.	[7]
A comprehensive review study on pure titanium niobium oxide as the anode material for LIBs	This work discussed the various approaches (i.e, solid-state, solvo/hydrothermal, sol-gel, and electrospinning) for tailoring dimensions (1D and 3D), morphologies, structural defect of titanium niobium oxides (i.e., $TiNb_2O_7$ and $Ti_2Nb_{10}O_{29}$) anodes for LIBs.	[8]
Recent progress and perspectives on alloying anodes for PIBs	This summarized the recent progress of metals (Sn, Sb, Sb, Bi, SnP), composites (i.e., Sn-C, Sb-C, Sb/Mxene, Bi@N-CT) and binary alloys (SnSb and SbBi) anodes for PIBs and their fundamentals.	[9]
Insights into metal/metalloid-based alloying anodes for PIBs	This gave overview of volumetric capacities and trend of metal/metalloid (Sb, Bi, Ge, Sn and Pb), oxides/sulfides (Sb_2O_3, Sb_2S_3, and SnS_2,), composites (Sb_2Se_3@C, and Sn@rGO,)	[10]

	and alloys (BiSb, SnSb, SiGe, Bi_2WO_6, $Pd_3Nb_4O_{13}$, and $SnSb_2Te_4$,) anodes for improved PIBs with much focus on the reaction mechanism and structural-performance relationship	
Applications of low-melting-point metals in rechargeable metal batteries	This emphasized the progress of utilizing low-melting point metals (i.e., In, Ga, Hg) and their alloys with others (Mg, Zn, Sn, Cu, Ge, Ca and Al) as remarkable anodes for LIBs, SIBs, PIBs, Mg-ion (MIBs) and Zn-ion batteries (ZIBs)	[11]
Dealloyed nanoporous materials for rechargeable lithium batteries	This highlighted the development and microstructural regulation of dealloyed nanoporous metals (i.e, Si, Ge, Tn, and Sn), metal oxides (Fe_3O_4, Mn_3O_4, Co_3O_4, CuO, GeO_2 and TiO_2) and metal sulfides (Fe_3S_4, Co_9S_8, and CuS) and their alloys with other metals (Ag, Cu, Mo, Ge, Zn, and Al) anode materials for rechargeable LIBs.	[12]
Recent advances in alloy-based anode materials for PIBs	This gave an overview of metals (Sn, Sb, and Bi), phosphides (K-P, Sn_xP_y, and GeP_5) and their binary alloys with other metals (Sb, Si, Pb, and Ge) anodes with regards to their morphology, potassium storage activity, phase transition mechanism, solid electrolyte interphases formation and ionic transport kinetics in PIBs.	[13]
Antimony-based nanomaterials for high-performance PIBs	This presented the strategies for designing and synthesizing Sb metal, chalcogenides (Sb_2S_3, and Sb_2Se_3), composites (Sb/C, Sb/CNS,	[14]

MXene@Sb, MoS_2/Sb, BiSb/C, Sb_2S_3/C, Sb_2Se_3/C and FeSb/NC) and alloy (Sb-Co, Sb-Fe, SnSb, and BiSb) anodes for PIBs, in addition to electrolyte optimization.

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