Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

TableS1 Explanation of relevant specialized terms

Specialized term	Interpretation
sodium cathode material	sodium battery is a type of battery that uses sodium ions to move between the positive and negative electrodes of the battery to store and discharge electrical energy. The positive material is an important part of the battery that determines the amount of power the battery is able to store, as well as the performance of the battery when charging and discharging. The positive material is the substance that is installed in the positive terminal of the battery, which is usually a compound that can hold sodium ions.
layered transition metal oxides	layered transition metal oxides are a class of materials that are structured like a stack of paper. Each “layer” provides space for sodium ions to enter and leave, just as books can be taken out and put in on a shelf. In the cathode material of sodium batteries, this structure of layered oxides helps sodium ions move quickly, which is critical to the battery's charge and discharge rates.
Jahn-Teller effect	Jahn-Teller effect is a physical phenomenon that occurs in certain molecules or crystals when an uneven distribution of the electron cloud causes a distortion in the structure of the material, leading to changes in physical and chemical properties. In other words, it is like a sphere becoming a flattened or elongated shape due to uneven internal pressure. In sodium cathode materials, the Jahn-Teller effect may lead to structural instability of the material during charging and discharging, which may affect the lifetime and performance of the battery.
phase transition	phase transition in battery materials is a phenomenon in which the crystalline structure of a material changes during the charging and discharging process. For sodium cathode materials, they may undergo a transition from one crystalline phase change to another during the embedding (charging) and de-embedding (discharging) of sodium ions. For example, a transition from a layered structure to an amorphous structure, or between two different layered structures. The phase transition may be accompanied by an energy change, which is manifested as a voltage plateau or jump in the discharge curve of the cell.
cycling performance	When the battery undergoes one charge/discharge, it is called a cycle. Cycle performance refers to the number of cycles when the battery is charged and discharged under certain conditions, and when the discharge specific capacity of the

	battery reaches the specified value. The main reasons affecting the cycle life are: during the charging and discharging process, the surface area of the electrode active material decreases, the working current density rises, the polarization increases; the active material on the electrode falls off or transfers and so on

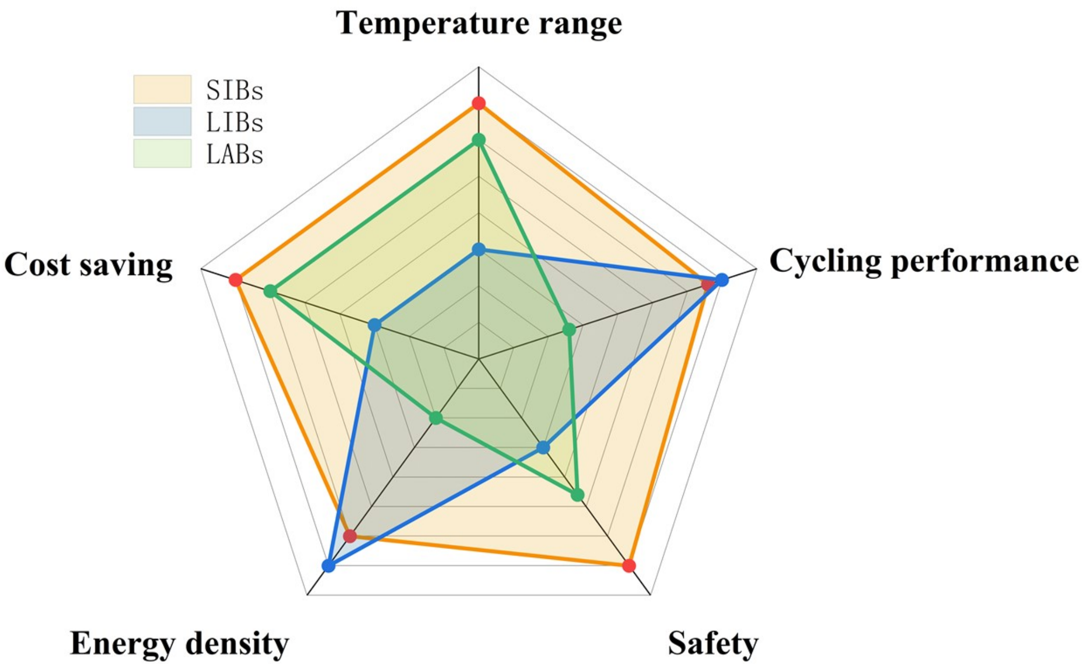

Figure S1: Comparison between SIBs and other battery systems[1]

Table S2 The advantages of layered oxides compared to other types of cathodes[2]

Program	Prussian blue/white compounds	Layered transition metal oxides	Polyanionic compounds
Advantages	**Simple synthesis process**	**High energy density**	**Theoretical high,Operating voltage.**
	Low cost of raw materials	**Excellent voltage platform**	**Excellent thermal stability,**
	High theoretical volume	**Great theoretical multiplier performance**	**Great cyclic stability**
	Great theoretical multiplier performance	**Ease of technology transfer**	**Superior air stability**
Disadvantages	**Difference in volumetric energy density**	**Poor air stability**	**Low energy density**

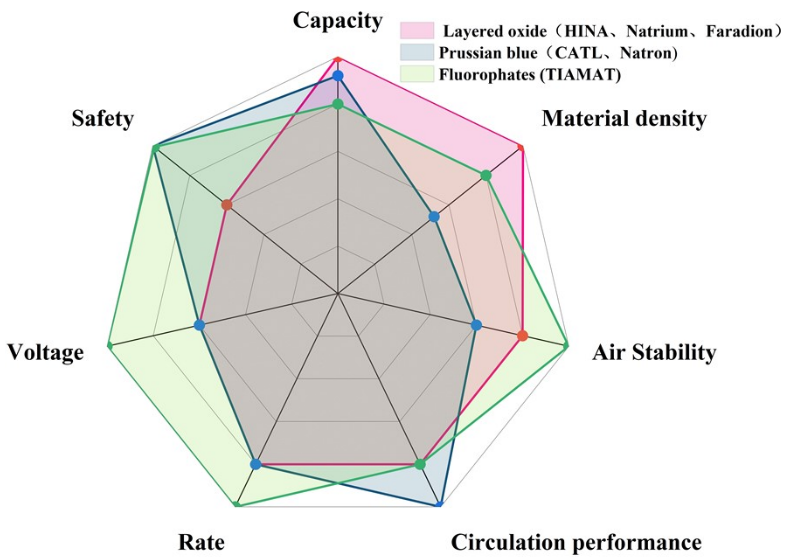

Figure S2 the advantages of layered oxides compared to other types of cathodes

Table S3 representative works comparison

	Cathode material	Capacity	Synthesis method
P2	**$Na_{0.67}Ni_{0.17}Co_{0.17}Mn_{0.56}Ti_{0.05}Mg_{0.05}O_2$[3]**	**151 mAh g^{-1} (2–4.5 V)87.7% after 300 cycles**	**coprecipitation**
	$Na_{0.5}Ni_{0.25}Mn_{0.75}O_2$[4]	**210 mAh g^{-1}(1.5–4.1 V)80% at 50 cycle**	**sol-gel method**
O3	**$NaNi_{0.25}Fe_{0.5}Mn_{0.25}O_2$[5]**	**131.7 mA h g^{-1}(2–4 V)81.6% after cycling at 1C for 100 cycles**	**solid-state reaction**
	NNMF-0.4A[6]	**135.7 mA h g^{-1}(2–4 V)76.7 mA g–1 after 500 cycles at a current density of 800 mA g–1 (10 C)**	**coprecipitation**
Heterogeneous structure	**P2/P3 Na0.7Li0.06Mg0.06Ni0.22Mn0.67O2[7]**	**119 mA h g^{-1}（2.0 –4.4 V）97.2% after 50 cycles**	**sol-gel method**
	P2@P3 integrated spinel oxide cathode $Na_{0.5}Ni_{0.1}Co_{0.15}Mn_{0.65}Mg_{0.1}O_2$[8]	**153.8 mAh g^{-1}（1.5-4.1V） 80.6% after 200 cycles**	**thermal polymerization method followed by high-temperature annealing**

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