

Supplementary Information for

Solid-state inorganic electrolytes for next generation potassium batteries

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In this work, the Piling-Bedworth ratio R_{PB} is defined as the ratio of the molar volume of potassium compounds to the molar volume of potassium metal and was calculated as follows:

$$x K + y A \rightarrow K_x A_y$$
$$R_{PB} = \frac{V_{K_x A_y}}{x \cdot V_K} = \frac{M_{K_x A_y} \cdot \rho_K}{x \cdot M_K \cdot \rho_{K_x A_y}}$$

Table S1: Piling-Bedworth ratios of various potassium compounds:

Compound	P-B ratio
KH	0.64
KF	0.53
KOH	0.62
KO ₂	0.76
K ₂ O	0.46
K ₂ O ₂	0.59
K ₂ CO ₃	0.65
KHCO ₃	1.05
KS	0.84
KS ₃	0.72
K ₂ S	1.55
K ₂ S ₃	0.93
K ₂ S ₅	1.29
K ₂ SO ₃	0.77
K ₂ SO ₄	0.75
K ₂ S ₂ O ₇	1.27

Table S2: Experimentally determined conductivities at specified temperatures, as well as activation energies, E_A , for various K^+ and Na^+ ionic conductors. All values given are for bulk compounds, except for E_A ($K_2Fe_4O_7$) which was determined from a single crystal measurement.

Composition	Conductivity ($S\ cm^{-1}$) ¹⁾	Temperature ($^{\circ}C$)	E_A (eV)	Reference
K-β-Alumina*	6.5×10^{-5}	25	0.29	1, 2
Na-BASE	4.5×10^{-2}	150	0.29	3
KAlO₂	1×10^{-3}	400	0.33	4, 5
K_{1.90}Pb_{0.05}AlO₂	2.5×10^{-3}	400	0.29	5
K_{0.4}Cd_{0.3}FeO₂	2.5×10^{-2}	300	0.24	6
KGaO₂	1×10^{-4}	400	0.47	4, 6
K_{0.7}Sr_{0.15}GaO₂	1×10^{-2}	400	0.23	4, 7
K₂Fe₄O₇	5×10^{-2}	25	0.08 ^(single crystal)	1
K_{1.8}Fe_{1.9}P_{0.1}O₄	7.6×10^{-2}	300	0.35	8, 9
K₃Sb₅P₂O₂₀	2×10^{-5}	300	0.52	10, 11
K_{1.6}Zn_{0.8}Ti_{7.2}O₁₆	1.4×10^{-4}	190	0.11	12, 13
K₂B₁₂(OH)₁₂	3.7×10^{-6}	390	0.89	14
KB₃H₈	2.6×10^{-7}	140	0.45	14
KB₃H₈ * NH₃B₃H₇	1.3×10^{-4}	55	0.44	14
KB₁₁H₁₄	2.0×10^{-5}	100	0.56	14
K₃BH₄B₁₂H₁₂	3.3×10^{-5}	330	0.38	14
KCB₁₁H₁₂	1.1×10^{-1}	90	0.585	14
K₃OI	5.6×10^{-3}	231	1.13	15
K_{2.9}Ba_{0.05}OI	3.5×10^{-3}	250	0.36	15
KNH₂	3.1×10^{-5}	70	0.33	16
KSi₂P₃	1×10^{-4}	25	0.20	17
K₃SbS₄	2.5×10^{-6}	20	0.27	18
Na_{2.88}Sb_{0.88}W_{0.12}S₄	3.2×10^{-2}	20	0.18	19
K_{2.92}Sb_{0.92}W_{0.08}S₄	7.7×10^{-5}	20	0.27	18
K_{2.98}Sb_{0.91}S_{3.53}Cl_{0.47}	3.2×10^{-4}	20	0.26	20

Table S3: Neutron scattering lengths and cross sections of selected elements and their isotopes with the bound coherent scattering cross section COH XS, bound incoherent cross section INCOH XS and absorption cross section ABS XS in barn²¹.

	COH XS (B)	INCOH XS (B)	ABS XS (B)
Li	0.454	0.92	70.5
⁷ Li	0.619	0.78	0.0454
Na	1.66	1.62	0.53
K	1.69	0.27	2.1
⁴⁰ K	1.1	0.5	35

Supplementary References

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