Supporting Information

Fast kinetics of Mg$^{2+}$/Li$^+$ hybrid ions in polyanion Li$_3$V$_2$(PO$_4$)$_3$ cathode in wide temperature range

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Figure S1 (a) Cyclic Voltammetry of LVPLAPC-LiCl|Mg half-cell at scan rate ranging from 0.2 to 2.0 mVs$^{-1}$, and (b) Relationship between square root of scan rates and oxidation/reduction peaks currents.
Figure S2 Cyclic Voltammetry of LVPLMg/Li-BHIMg half-cells: (a) at 0.5mVs$^{-1}$, (b) at scan rates ranging from 0.2 to 1.0mVs$^{-1}$, and (c) Relationship between square root of scan rates and oxidation/reduction peaks currents.
Figure S3 (a) Charging and discharging curves of \textit{LVPI}Mg/Li-BH‖Mg half-cell at current densities ranging from 50mAg\(^{-1}\) to 2500 mAg\(^{-1}\), (b) Long-term cycle life of hybrid cells at 100mAg\(^{-1}\), (c) 1\(^{\text{st}}\), 2\(^{\text{nd}}\), and 100\(^{\text{th}}\) charge-discharge curves of \textit{LVPI}Mg/Li-BH‖Mg half-cell at current density of 100mAg\(^{-1}\), and (d) 1\(^{\text{st}}\), 2\(^{\text{nd}}\), and 100\(^{\text{th}}\) charge-discharge of \textit{LVPI}APC-LiCl‖Mg half-cell at current density of 100mAg\(^{-1}\).
Figure S4 Electrochemical characterizations of LVP‖APC‖Mg half-cell at current densities of 100mA g⁻¹.
Figure S5 (a) Polarization of different electrolyte systems as a function of environmental temperatures, (b) Low temperature electrochemical performance of LVP‖LiPF6‖Li half cells at 100mAg⁻¹.
**Figure S6** Surface morphology of magnesium anode (a) before, and (b) after cycling in APC-LiCl electrolyte for 200 cycles.