

## Supporting Information

### **Fast kinetics of Mg<sup>2+</sup>/Li<sup>+</sup> hybrid ions in polyanion Li<sub>3</sub>V<sub>2</sub>(PO<sub>4</sub>)<sub>3</sub> cathode in wide temperature range**

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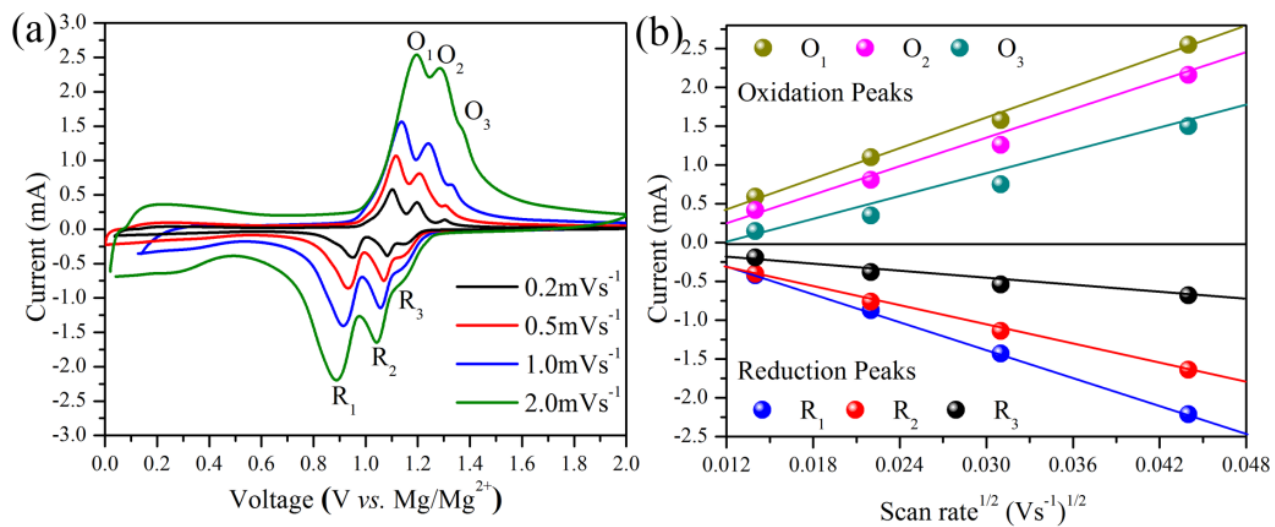
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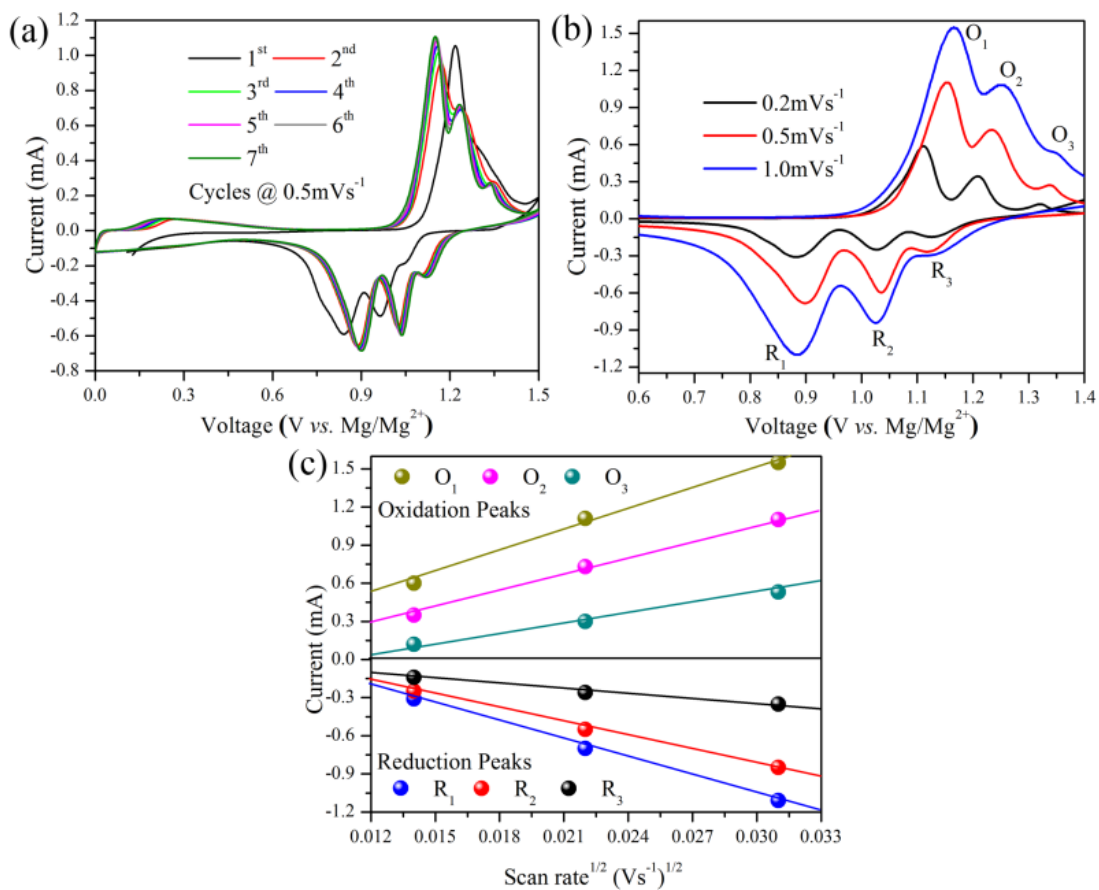
[zhanghm@dicp.ac.cn](mailto:zhanghm@dicp.ac.cn)

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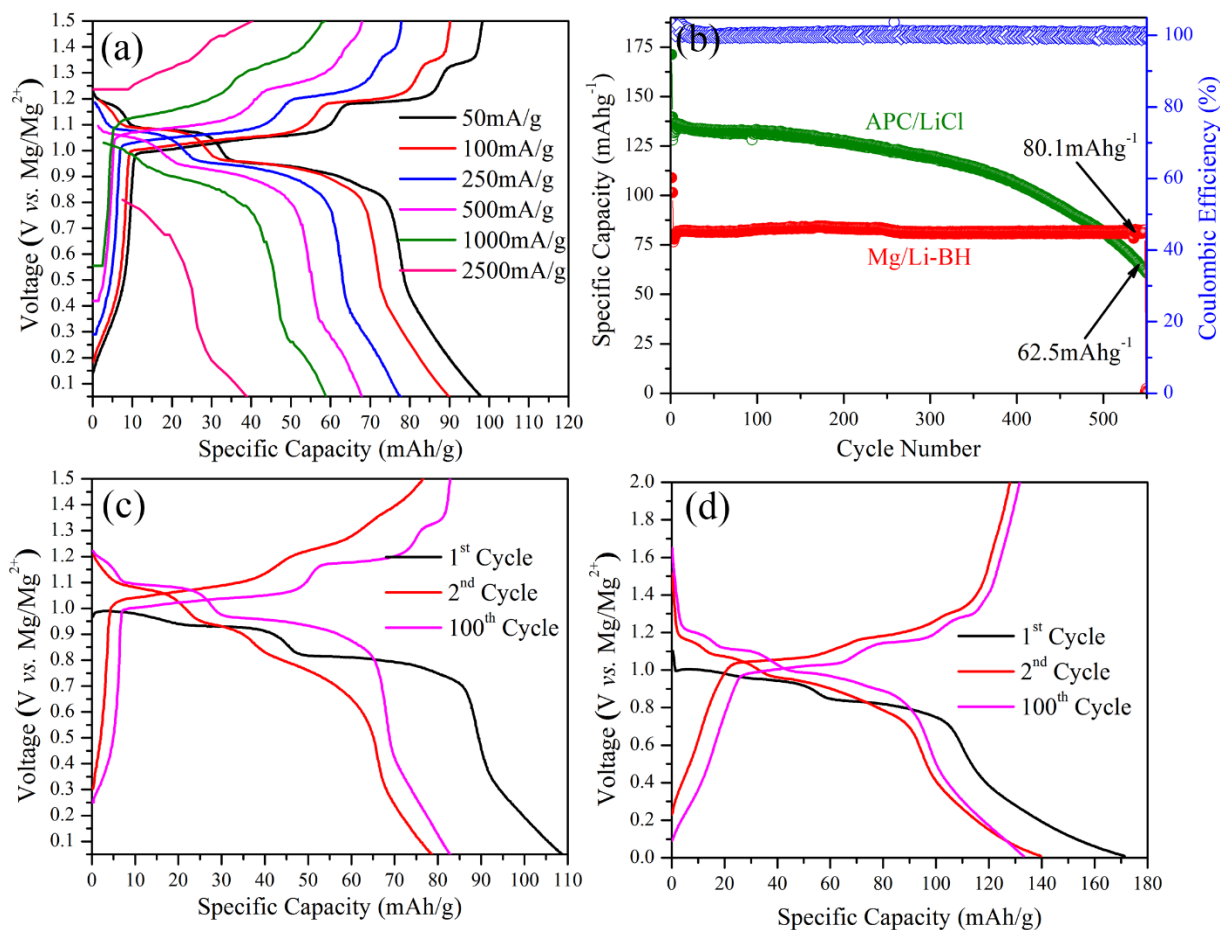
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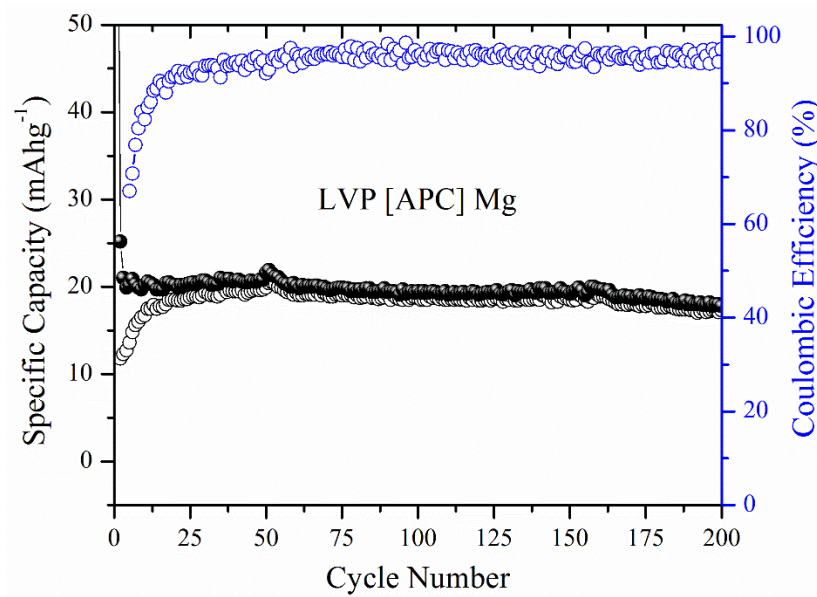
**Figure S1** (a) Cyclic Voltammetry of LVPI/APC-LiCl/Mg half-cell at scan rate ranging from 0.2 to 2.0mVs<sup>-1</sup>, and (b) Relationship between square root of scan rates and oxidation/reduction peaks currents.



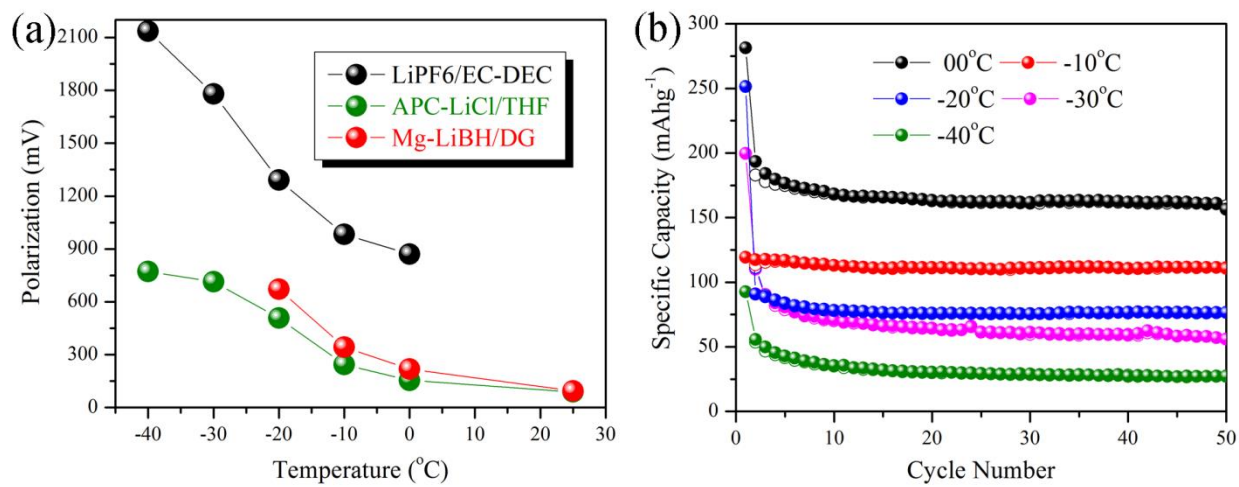
**Figure S2** Cyclic Voltammetry of LVP||Mg/Li-BH||Mg half-cells: (a) at  $0.5 \text{ mVs}^{-1}$ , (b) at scan rates ranging from  $0.2$  to  $1.0 \text{ mVs}^{-1}$ , and (c) Relationship between square root of scan rates and oxidation/reduction peaks currents.



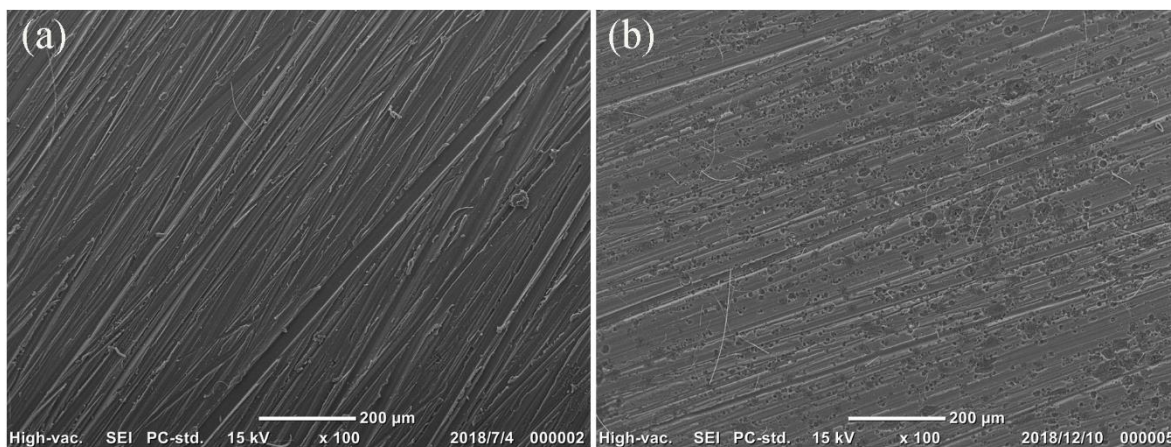
**Figure S3** (a) Charging and discharging curves of LVP||Mg/Li-BH||Mg half-cell at current densities ranging from 50mA<sup>g</sup><sup>-1</sup> to 2500 mA<sup>g</sup><sup>-1</sup>, (b) Long-term cycle life of hybrid cells at 100mA<sup>g</sup><sup>-1</sup>, (c) 1<sup>st</sup>, 2<sup>nd</sup>, and 100<sup>th</sup> charge-discharge curves of LVP||Mg/Li-BH||Mg half-cell at current density of 100mA<sup>g</sup><sup>-1</sup>, and (d) 1<sup>st</sup>, 2<sup>nd</sup>, and 100<sup>th</sup> charge-discharge of LVP||APC-LiCl||Mg half-cell at current density of 100mA<sup>g</sup><sup>-1</sup>.



**Figure S4** Electrochemical characterizations of **LVP|APC||Mg** half-cell at current densities of 100mA<sup>g</sup><sup>-1</sup>.



**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 100mA g<sup>-1</sup>.



**Figure S6** Surface morphology of magnesium anode (a) before, and (b) after cycling in APC-LiCl electrolyte for 200 cycles.