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Protective Coating Layers via Phosphazene Compounds for Stabilizing Silicon Anode Materials

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Abstract : In recent years, lithium-ion batteries (LIBs)are widely used in electric vehicles (EVs) and mobile energy storage devices (ESDs), which has led to higher requirements for energy density. To fulfill these requirements, tremendous attention has been paid to design advanced LIBs with various siliconactive materials as alternative negative electrodes to replace graphite (372 mAh g^{-1})due to their high theoretical gravimetric capacity (4200mAh g^{-1}). However, silicon as potential anode material suffers from huge volume changes during charging and discharging and has poor electronicconductivity which negatively impacts the long-term performance and preventshigh silicon contents from practical application. Additionally, an unstable crystalline silicon structure tends to pulverization during the (de)lithiation process. To compensate for the volume changes, alleviate pulverization, and maintain high electronicconductivity, silicon-doped graphite composites with protecting coating layers are a promising approach. In this context, phosphazene compounds are investigated concerning their silicon protecting properties in silicon-doped graphite composites. In detail, electrochemical performance measurements in pouch full-cells(NCM523||SiOx/C), supressing gas formation properties, and post-mortem analyzes were carried out to characterize phosphazene compounds as additive materials. The introduction of the dual-additive approach in state-of-the-art electrolytes leads to synergistic effects between FEC and phosphazene compounds which accelerate the durability of silicon particles and results in enhanced electrochemical performance.

Keywords : silicon, phosphazene, solid electrolyte interphase, electrolyte, gasmeasurements
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