

A Pyrene-Polyacrylic Acid-Polyrotaxane Supramolecular Binder Network for High Performance Silicon Negative Electrodes

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As high energy density lithium-ion batteries are required, the contents of silicon in anode are increasing. However, the weight portion of silicon monoxide (SiO_x , $x \approx 1$) is only less than 10 wt% because of unstable cycle life. Polymeric binders that can support in maintaining the electrode integrity and interfacial stability of SiO_x electrodes are desired to carry out higher contents of SiO_x .

Here, we describe that a pyrene-poly(acrylic acid) (PAA)-polyrotaxane (PR) supramolecular network as a polymeric binder for SiO_x . The noncovalent modification of a carbon-coated SiO_x is accomplished by using a hydroxylated pyrene derivative via the π - π stacking interaction, which enables strong hydrogen bonding interactions between carboxylic acid in the PR-PAA network and hydroxyl moiety. Furthermore, the ring sliding of PR endows superior elasticity to the entire binder network, effectively distributing the stress during cycling and alleviating the electrode swelling. Based on these sequential supramolecular interactions of the hierarchical binder network, highly robust cycling performance of SiO_x electrode was achieved at commercial levels.