Highly elastic binders integrating polyrotaxanes for silicon microparticle anodes in lithium ion batteries

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Lithium-ion batteries with ever-increasing energy densities are needed for batteries for advanced devices and all-electric vehicles. Silicon has been highlighted as a promising anode material because of its superior specific capacity. During repeated charge-discharge cycles, silicon undergoes huge volume changes. This limits cycle life via particle pulverization and an unstable electrode-electrolyte interface, especially when the particle sizes are in the micrometer range. We show that the incorporation of 5 weight % polyrotaxane to conventional polyacrylic acid binder imparts extraordinary elasticity to the polymer network originating from the ring sliding motion of polyrotaxane. This binder combination keeps even pulverized silicon particles coalesced without disintegration, enabling stable cycle life for silicon microparticle anodes at commercial-level areal capacities