Synthesis, characteristics and electrochemical performances of N, N-(*p*-phenylene) bismaleamate and its fluoro-substitution compound on organic anode materials in lithium-ion battery

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Traditional lithium ion battery composes lithium transition metal oxide as a cathode and graphite as an anode. Due to the global warming and the increment of electric vehicle marketing, the reduced-carbon policy and the requirement of high energy density, several techniques have been studied in order to replace the graphite such as metalloid and organic compounds. However, metalloid suffers tremendous problems when alloys with lithium ions, including the huge volume expansion and the electrochemical irreversibility. The organic compounds also present some drawbacks such as low electronic conductivity and low thermal stability, respectively. In this research, the bismaleamate and its fluoro-substitution polymer have been synthesized and studied in order to prevent above problems. The calculation and electrochemical performance show that the fluoro-substitution on bismaleamate significantly decreases the energy band gap around 0.02 eV and provides 430.0 mAh g^{-1} after 350 cycles. The c-rate performance improves with the low energy band gap when operates at 10C/ 10C (190 mAh g^{-1}). The Brunauer-Emmett-Teller analysis shows that the fluoro-substitution bismaleamate has four times higher of surface area and ten times bigger of pore size compares with the bare bismaleamate. The fluoro-substitution incurs the obvious three-dimensional steric effect and unsymmetrical structure, which is able to provide the excellent ionic transfer. The X-ray photoelectron spectroscopy shows the weak electron-withdrawing effect on fluoro-substitution dramatically inhibits the formation of solid electrolyte interphase (SEI) and delivers an interesting reaction mechanism for its structure rearrangement. *Operando* X-ray diffraction pattern confirms the changes of crystal phase of bismaleamate and its fluoro-substitution. New organic anode material, bismaleamates have excellent performances concerning the capacity, c-rate, and cycle life, which are eligible for enabling high potential applications in lithium-ion and beyond-lithium secondary batteries.

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