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Less is more: tiny amounts of insoluble multi-functional microporous additive plays a big role in lithium-ion batteries

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Binders play an important role in multi-component electrodes for rechargeable batteries, which suffer from poor electronic and ionic conductivity. Binder-free electrodes provide another way to resolve problems, where sophisticated structure construction is required. A new concept of electrode processing alternative to binder-containing and binder-free electrodes was established. A multi-functional PIM-1 (a polymer with intrinsic microporosity) additive was used instead of PVDF to form mechanically processable Li secondary battery cathodes. Due to its unique nanoporous structure built by the spiro-containing rigid aromatic polymer chain, only a tiny amount of PIM-1 in the $\text{LiNi}_{0.8}\text{Co}_{0.1}\text{Mn}_{0.1}\text{O}_2$ cathode is needed to retain good performance, far below the typical composition for PVDF. Homogeneous dispersion of carbon black is achieved by PIM-1, which stabilizes the electrode and increases the electronic conductivity. Different from PVDF, mechanical buffering by stiff PIM-1 yields crack-free electrodes after cycles. Moreover, an inorganic rich cathode-electrolyte interface layer is formed via a desolvation process promoted by PIM-1, because of its strong binding ability with lithium ions, which is beneficial for cyclic stability and rate capability.

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