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Interfacial energy materials for flexible, safe batteries: Gummy electrolyte and gummy binder

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Two conformable interfacial energy materials have been designed and fabricated for battery applications, i.e. gummy electrolyte and gummy binder with a chewing gum-like appearance (thereafter called "gummy" material). Electrolytes play a very important role for battery safety and performance. The gummy electrolyte was demonstrated with beneficial properties, such as high ionic conductivity (liquid electrolyte level), good mechanical properties (solid materials level), and strong adhesion (adhesive level), as well as safety characteristics providing thermal protection for batteries. The other interfacial energy material, the gummy binder, is a dual-conductive adhesive for fabricating high performance battery electrodes. The primary function of conventional electrode binders is "binding" particles in electrodes without directly contributing to the performance of electrodes/batteries, as they cannot conduct electrons and/or ions. The gummy binder possesses high ionic and electronic conductivities, strong adhesion and appropriate mechanical/rheological properties, as well as excellent conformability and processibility. As it is a dual-conductive adhesive, the gummy binder is an effective solution to address the issues that are relevant to the interface weakness and structural instability. Firstly, the adhesive electrode matrix being the continuous phase can provide stable structures and "robust" interfaces via strong adhesion with the active electrode particles (the filler phase). The results enhance the durability of the electrodes and thus the batteries. Secondly, the continuous phase with uniform conductive interfaces provides the base for dual conductive functions (for both ions and electrons) inside the electrodes. Therefore, with such a matrix material, "robust" interfaces, which are defined as stable with high interfacial adhesion and good conductive properties for ion/electron transfer, can be built inside the electrodes. Thirdly, the gummy binder as the conductive continuous phase can also promote heating transport/releasement, thus the safety of the batteries can be improved.

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