

General comments:

SINOCHEM LANTIAN CO., LTD. specializes in the import, export, and sales of chemical products, specialty chemicals, and new chemicals. We emphasize the critical role of PVDF binders in battery manufacturing. Presently, finding a perfect substitute for this application is challenging, and certifying alternatives would entail additional time. Hence, we recommend exempting this application from the PFAS Restriction Act.

To elaborate:

Interfacial bonding strength of PVDF is paramount. PVDF forms a β -phase at the current collector interface, significantly augmenting the interfacial bonding strength. This ensures a tight connection between the current collector and other components, thereby facilitating effective charge transfer.

Electrochemical stability of PVDF is a critical factor in binder performance assessment. The window width between PVDF's HOMO and LUMO orbitals surpasses typical electrolyte requirements, assuring stable electrochemical performance during charge and discharge processes.

Low swelling of PVDF is also a significant performance criterion. PVDF exhibits a swelling rate in the electrolyte of less than 10%, ensuring structural stability during use, without significant alterations due to electrolyte action. The ion conductivity of PVDF experiences a notable increase after swelling in the amorphous region, a vital aspect for efficient battery operation.

PVDF's high melting point, exceeding 160 degrees, is a notable advantage. This characteristic allows the battery to maintain control over thermal runaway at elevated temperatures, effectively averting safety concerns associated with temperature rise. Additionally, PVDF demonstrates good molecular flexibility, with a glass transition temperature (T_g) of approximately -37 degrees in the amorphous region, ensuring reliable performance in low-temperature conditions.

The unique advantage of PVDF in batteries lies in the trace release of F ions. In current battery systems, F ions contribute to the formation of the main SEI film as LiF and assist in the formation of AlF_3 on the surface of the current collector, which is why PVDF surpasses other products in cycling performance.

Table 1 illustrates that, compared to other binder materials, PVDF exhibits significant advantages in bonding strength, cohesion, flexibility, processability, initial efficiency, energy density, cycling performance, rate performance, and internal resistance. While materials like PAA, HNBR, and ACM can achieve similar performance levels in terms of bonding strength, initial efficiency, rate performance, and internal resistance, PVDF maintains a substantial edge.

Table 1. Performance Comparison of Different Binder Products in Battery.

Binder	Adhesive	Flexibility	Processability	First charge	Energy density	Cycle performance	Rate performance	Internal resistance
--------	----------	-------------	----------------	--------------	----------------	-------------------	------------------	---------------------

efficiency								
PVDF	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
PAA	⊙	△	△	⊙	○	△	⊙	⊙
HNBR	⊙	○	⊙	⊙	○	△	⊙	⊙
PI	△	△	X	X	△	X	△	X
ACM	⊙	△	△	○	○	△	⊙	⊙

⊙○△X Representing excellent, good, fair, poor

In summary, PVDF serves several pivotal functions as a binder in batteries. Its exceptional performance guarantees stable and efficient battery operation across diverse conditions. The irreplaceable role of PVDF as a binder in lithium batteries cannot be emphasized enough.