ANPOLY
Advanced Natural Polymer

GreenNet Binder

Eco-Friendly Waterborne CNF-Li Binder for High-Performance Batteries

SUSTAINABLE DEVELOPMENT GOALS

GreenNet Binder

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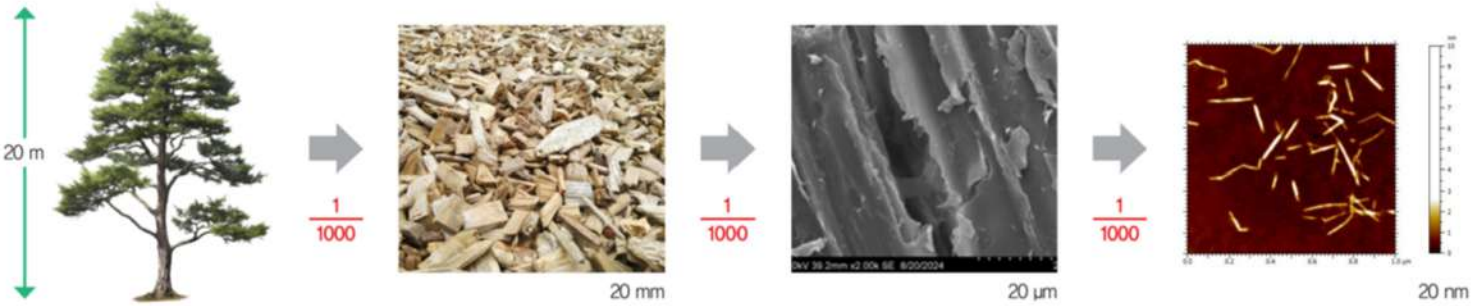
ANPOLY is a high-tech materials platform company that develops and commercializes eco-friendly, high-performance materials derived from plant-based nanocellulose. GreenNet Binder is a next-generation, bio-based binder that ensures high structural stability and uniform conductive network formation while reducing interfacial resistance and performance degradation under high-rate charge-discharge conditions. Engineered from plant-based nanocellulose with lithium-functionalized carboxylate sites, it provides a stable electrode environment that enhances lithium-ion transport, fast-charging capability, and long-term cycle durability.

What is CNF?

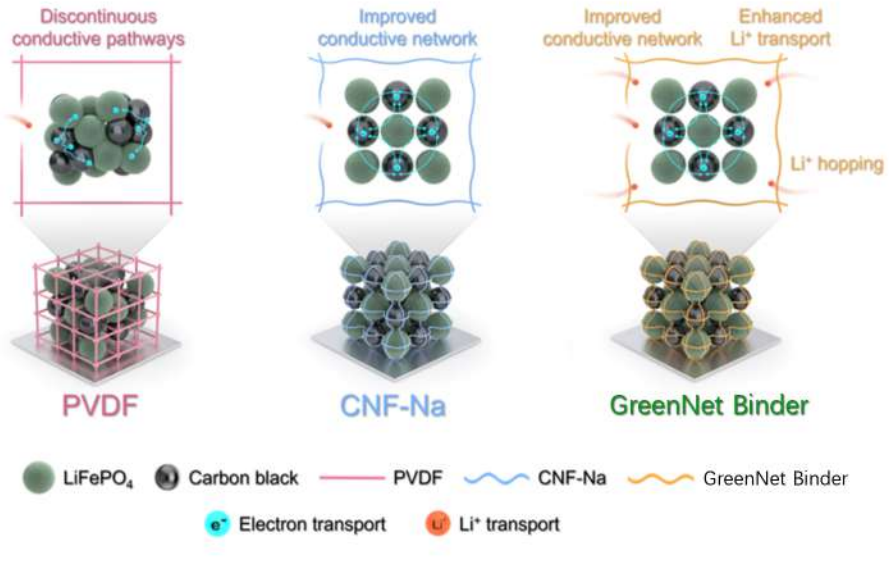


Tree | Wood Chips | Pulp | Nanocellulose

CNF (Cellulose NanoFiber) is a new eco-friendly fiber made by breaking down cellulose from trees or plants into nanoscale fibers. CNF is extremely strong while weighing only one-fifth as much as steel and offers unique advantages such as transparency, biodegradability, and high-thermal stability, making it a promising next-generation material. ANPOLY has proprietary technology to produce nanocellulose from wood pulp, rice husks, and coffee grounds, and has developed and commercialized secondary battery binders, separators, biocomposites, and ECMs using this nanocellulose.

GreenNet Binder

GreenNet Binder is an eco-friendly, water-based binder that overcomes the limitations of conventional aqueous binders, such as low mechanical stability and poor electrical conductivity caused by insufficient conductive network formation. It reduces environmental impact during battery cell manufacturing while providing high stability and increased contact between active materials, resulting in improved battery performance. Developed by ANPOLY, GreenNet Binder is a high-performance binder made from plant-based nanocellulose. It eliminates the environmental concerns, toxicity, and regulatory constraints associated with conventional organic binders such as PVDF and NMP, while enhancing lithium-ion conductivity and delivering superior high-rate charge-discharge performance.



GreenNet Binder

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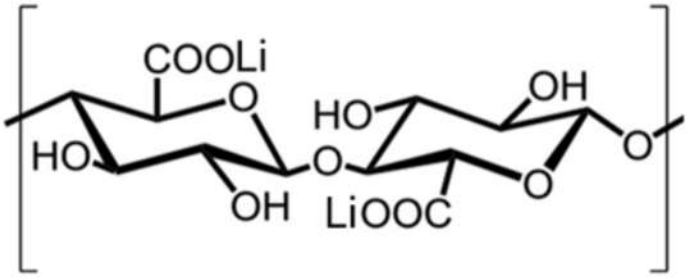
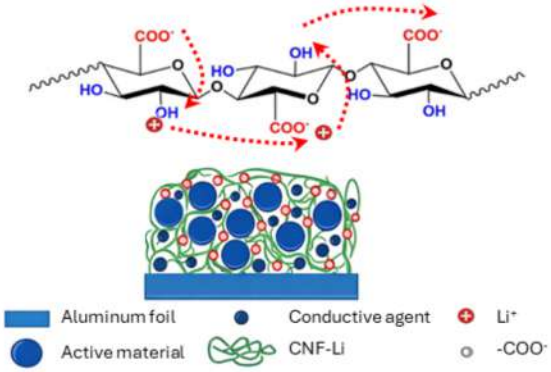
ANPOLY provides GreenNet Binder in both powder and solution forms to accommodate a wide range of battery manufacturing processes. CNF-Li is produced by chemically binding lithium ions to the carboxylate (–COO-) sites on the surface of CNF, enabling stable lithium-ion interaction within the electrode structure. Depending on specific processing conditions and performance requirements, users can select either the powder or solution form to optimize dispersion, coating behavior, and overall battery performance.

Chemical Structure of GreenNet Binder

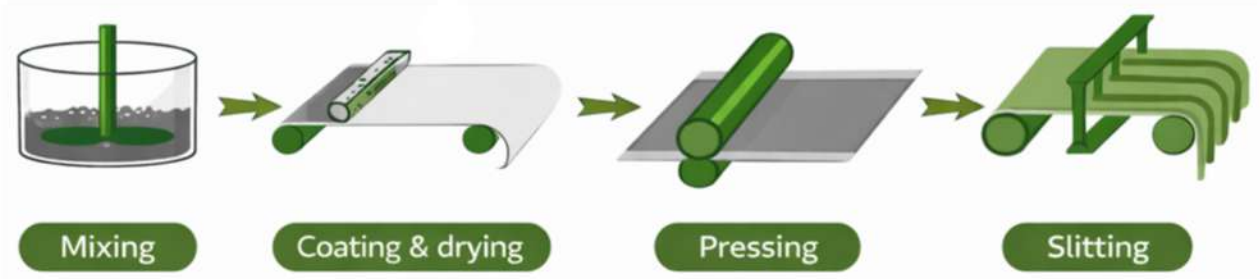


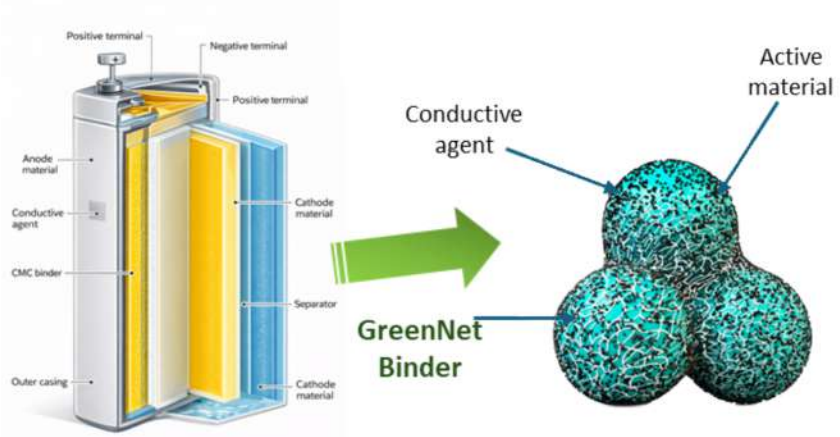
GreenNet Binder's Structure



Li-ion conduction of GreenNet Binder

Electrode Manufacturing Process





GreenNet Binder Slurry

GreenNet Binder Coin Cell

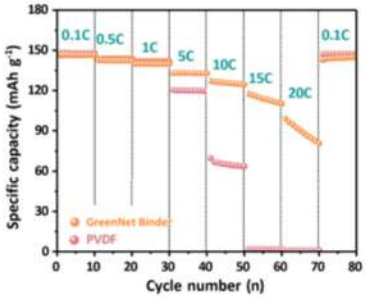
Advantages in battery electrochemistry

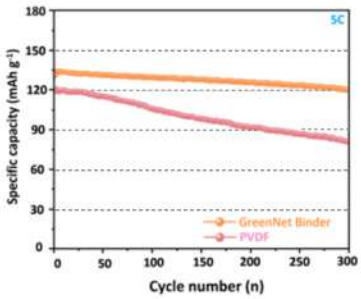
Structural stability of the electrode layers ensures reliable performance even at high rates
Minimized resistance delivers fast charge-discharge capability with sustained cycle performance

GreenNet Binder

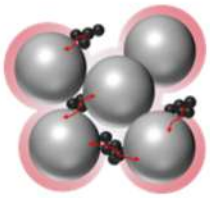
Charging Rate Comparison: GreenNet Binder vs PVDF

GreenNet Binder demonstrates high-capacity retention even under fast charge-discharge conditions, making it well suited for fast-charging applications. After 300 cycles, the capacity retention remains above 89.8%, indicating excellent durability and long-term performance stability.





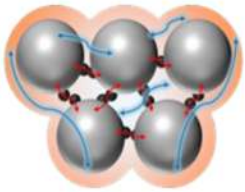
Number of Cycle & ICE



119.69 mAh g-1 (Initial capacity)
High polarization

Rapid decrease capacity

PVDF



133.89 mAh g-1 (Initial capacity)
Low polarization
→conductive network
Good capacity retention (89.8%)
→Additional Li^+ pathways

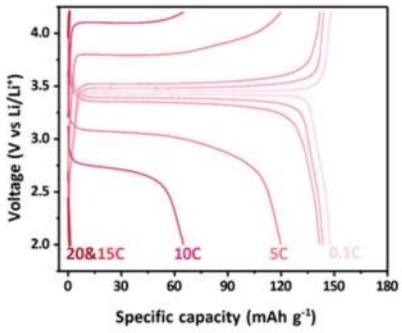
GreenNet Binder

#Cycle	1st capacity: 119.69 300th capacity: 80.37	Cycle maintenance rate (300th): 67.1%
	1st capacity: 133.89 300th capacity: 120.23	Cycle maintenance rate (300th): 89.8%
ICE	Charging capacity: 172.14 Discharging capacity: 119.69	Efficiency: 69.5%
	Charging capacity: 170.05 Discharging capacity: 133.89	Efficiency: 78.7%

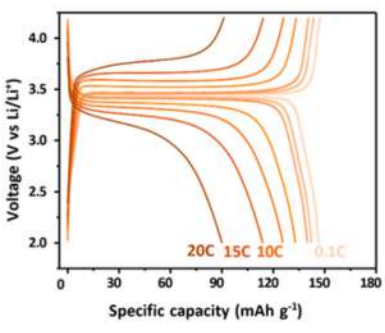
PVDF GreenNet Binder

Fast Charging Comparison: GreenNet Binder *vs* PVDF

PVDF



GreenNet Binder



PVDF shows significant capacity degradation during fast charging at 5C (left), whereas GreenNet Binder maintains a high-capacity retention rate even under ultra-fast charging conditions at 20C (right). Compared to PVDF, GreenNet Binder offers clear advantages in fast charge-discharge performance.

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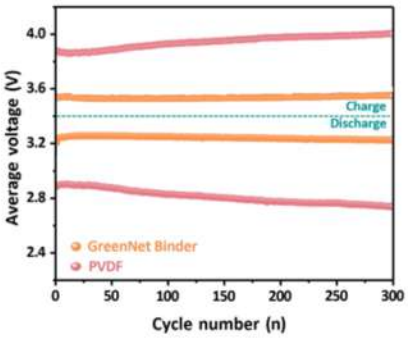
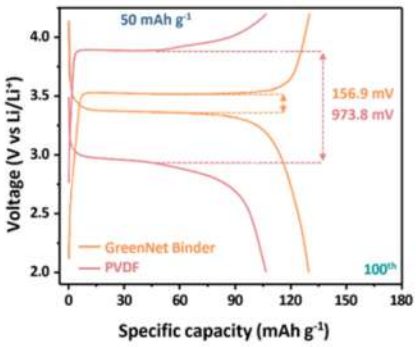
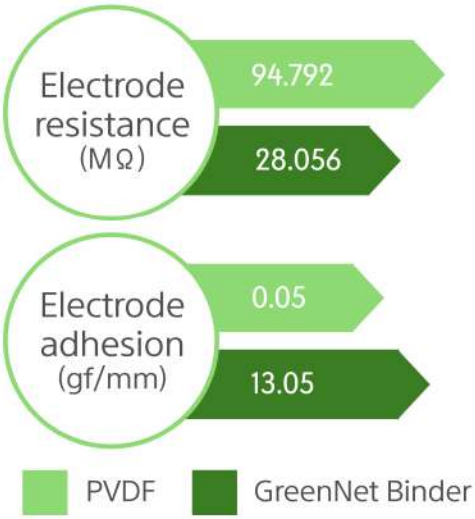
Stability Test Comparison: GreenNet Binder vs PVDF

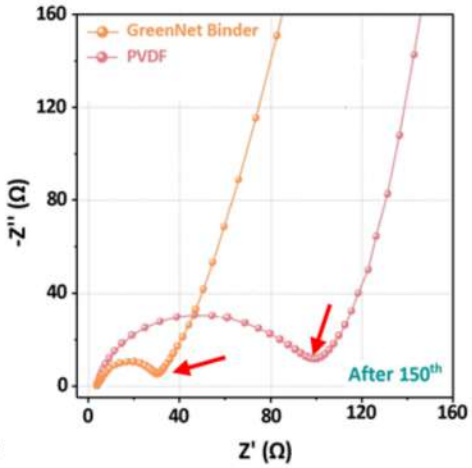
In the interfacial stability test, GreenNet Binder exhibits superior stability even at the initial interface, and maintains better interfacial integrity than PVDF during repeated cycling. After 100 charge-discharge cycles, PVDF shows interfacial degradation due to structural collapse, whereas GreenNet Binder preserves interfacial stability throughout the test.

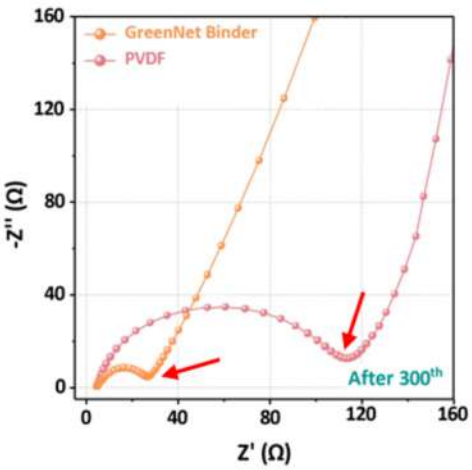




Electrical Conductivity and Electrode Adhesion







1. Electrical Resistance (left)

It enables uniform dispersion of the conductive material and active material, facilitating electron transport and reducing interfacial resistance, thereby preventing overvoltage.

2. Electrode Adhesion (left)

By strongly binding the active material and conductive material, it provides excellent structural stability, maintaining a stable network even during repeated charge-discharge cycles.

3. Both Graphs

In the case of PVDF, interfacial resistance gradually increased due to collapse of the interfacial structure (94.792 Ω at the 150th cycle→102.45 Ω at the 300th cycle). In contrast, GreenNet Binder (CNF-Li) stably maintained low interfacial resistance without interfacial side reactions or structural degradation (28.056 Ω at the 150th cycle→23.099 Ω at the 300th cycle).

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