



GRAPHENE CONDUCTIVE ADDITIVE FOR LI-ION BATTERIES

KEY FEATURES

- NMP-based
- Compatible with all commonly used cathode materials
- Cost-effective solution for higher energy and power applications

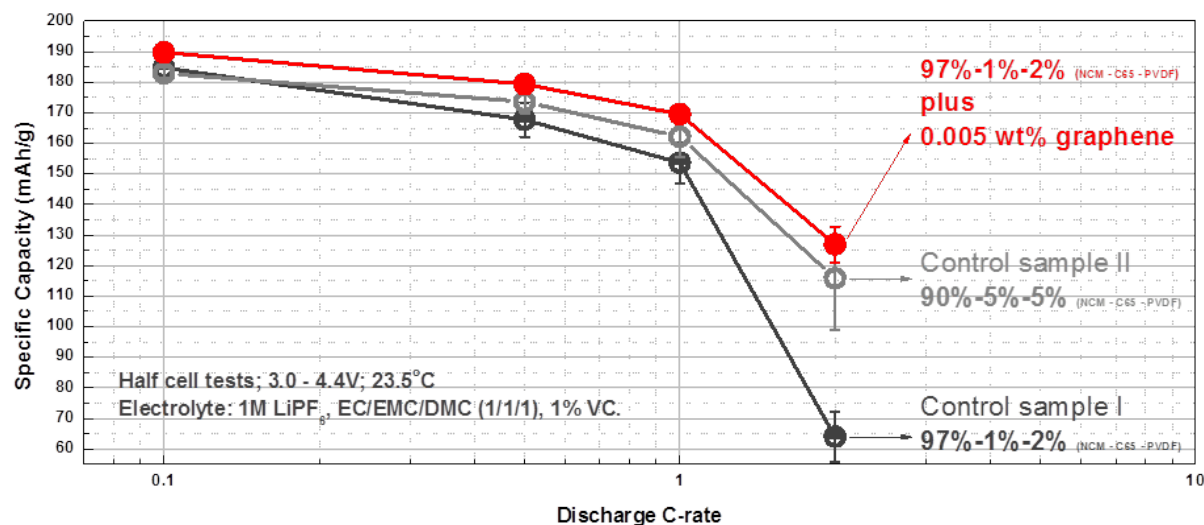
PRODUCT	GRAPHENE	SURFACTANT	SOLVENT
GSP-1000	1 wt%	2 wt% PVDF*	NMP

* Choice of PVDF brands are available upon request.

Ultra-low Loading, Great Improvement on Rate Performance

- By mixing 5g of GSP-1000 with 1 kg cathode material, equivalent to 0.005 wt% of graphene in cathode, discharge capacity at 2C can be enhanced by 95%.
- Graphene provides significant improvement over loadings with both high and low carbon black.

COMPARISON RATE OF PERFORMANCE



CONDITION OF TESTING SAMPLES

Component	Graphene added sample	Control sample I	Control sample II
NCM 622	97%	97%	90%
Super C65	1%	1%	5%
PVDF	2%	2%	5%
Graphene	0.005%	0%	0%
Areal density	19 mg _{NCM} /cm ²		16 mg _{NCM} /cm ²
Packing density	3.2 g/cm ³		3.1 g/cm ³

- Graphene conductive additive is recommended for reduction of use of traditional carbon black in cathode to achieve **higher energy density (↑20.5% at 2C discharge rate)**.
- **Cost of conductive additive could be reduced by >50%** when 4% carbon black is replaced by 0.005% graphene.

COMPARISON OF ENERGY DENSITY

Testing Conditions	Energy density * (Wh/Lpositive electrode)		Enhancement
	Testing Sample		
Half cell tests 3.0 - 4.4V At 23.5oC	97:1:2 ** +0.005 % graphene	90:5:5 **	
0.1C - 0.1C	2268	1965	+ 15.5%
0.5C - 0.5C	2122	1851	+ 14.7%
1C – 1C	1979	1710	+ 15.8%
1C – 2C	1438	1194	+ 20.5%
2C – 1C	1843	1539	+ 19.8%

* Energy density of positive electrode = Specific energy x Packing density x Ratio of active material

** 97:1:2 and 90:5:5 denote mass ratios of NCM 622 : Super C65 : PVDF

*** Electrolyte: 1M LiPF₆, EC/EMC/DMC (1/1/1), 1% VC.

Other Benefit: Pay Less on Shipping & Storage

- To achieve 0.005wt% graphene in 1kg of cathode material, only 5g of 1% GSP-1000 would be needed.
- Use 20x less dispersion than MWCNT.

How to use (mixing with 1 kg cathode material as an example):

1. Stir GSP-1000 using traditional mixer for <30 min before use to ensure optimum dispersion.
2. Take 5g GSP-1000 from (1) and add it to binder-dissolved NMP solution while mixing.
3. Add 1kg cathode materials and other additives into slurry while mixing.
4. Mix until slurry reaches homogeneity.

CONTACT US

Want to learn more? Contact G³ at
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