INOX GFL GROUP

BEYOND INFINITY

Advancing EV Battery Materials Solutions Globally

GFL®

GUJARAT FLUOROCHEMICALS

VALUE THROUGH GREEN CHEMISTRY

GFCL ev

Products Limited

GROUP'S JOURNEY

1987

1 · GFL incorporated as a Refrigerant manufacturer in India

1988

2 · Launch of a public issue.

· Established CFC Refrigerant gas, Hydrofluoric Acid units in Panchmahal, Gujarat.

2006

3 · Implementation of Clean Development Mechanism Project at Ranjit Nagar, Gujarat.

· Carbon Credits issued by the UNFCCC

2007

4 · Chemical complex at Dahej, Gujarat – with Caustic Soda & Chlorine, a Chloromethane & PTFE units and CPP

2009

5 · Wholly owned subsidiary in US

· Diversification into wind energy - India's leading wind energy solutions provider.

2011

6 · GFL's captive Fluorspar Mine in Morocco

2013

7 · Wholly owned subsidiary in Europe (Germany)

· Became globally leading supplier of PFOA Free Fluoropolymers

2014-16

- Capacity expansion for Monomers & Polymers
- GFL introduced the Fluonox® brand of FKM (Fluoroelastomers)
- New Fluoropolymers under the brand name INOFLON®

8

2018

9

- Launch of additives brand, INOLUB® - PTFE Micropowders & Polymer Processing Aids (PPA).

2019

10

- Launched PVDF under the brand name INOFLAR®

2020-21

11

- Added new site at Jolva, Gujarat
- Diversification into New Age Products: EV, Solar & Hydrogen
- Rated GOLD by Ecovadis in 2021

2023

12

- Commercialisation of $LiPF_6$ and PVDF
- Electrolyte Plant

2024 onwards

13

- Capacity expansion - $LiPF_6$/ PVDF
- Application and Performance Testing Lab
- EV Portfolio expansion: CAMs, Co-salts, and Additives

ABOUT THE INOXGFL GROUP

The INOXGFL Group proudly stands as one of India's most esteemed business conglomerates, with a rich history spanning over a century. The group has resiliently grown into a multibillion-dollar enterprise with diverse verticals including Refrigerants, Fluoropolymers, Specialty Chemicals, Wind Energy, and Renewables.

INOXGFL GROUP
BEYOND INFINITY

Chemical Business

Gujarat Fluorochemicals Ltd, a leading Indian Chemical Company

Business Verticals: Fluoropolymers, Fluorospecialties, Refrigerants & Bulk Chemicals.

GFCL EV is a 100% subsidiary of GFL, manufacturing a bouquet of critical materials for Lithium-ion Battery.

GFCL Solar & Green Hydrogen focusses on Proton Exchange Membranes required in hydrogen electrolysers & fuel cells, and PVDF back sheets for solar panels.

Renewable Energy Business

Inox Wind Ltd is a fully integrated player in the wind energy market and provides end-to-end turnkey solutions.

INOX Green Energy Services Limited is India's leading wind O&M services player with more than 10 years of operating history.

Inox Wind Energy Ltd is the holding company of the wind business.

MANUFACTURING LOCATIONS

DAHEJ, GUJARAT, INDIA

Fluoropolymers, Fluoroelastomers & Chemicals

RANJIT NAGAR, GUJARAT, INDIA

Fluorospecialities & Refrigerants

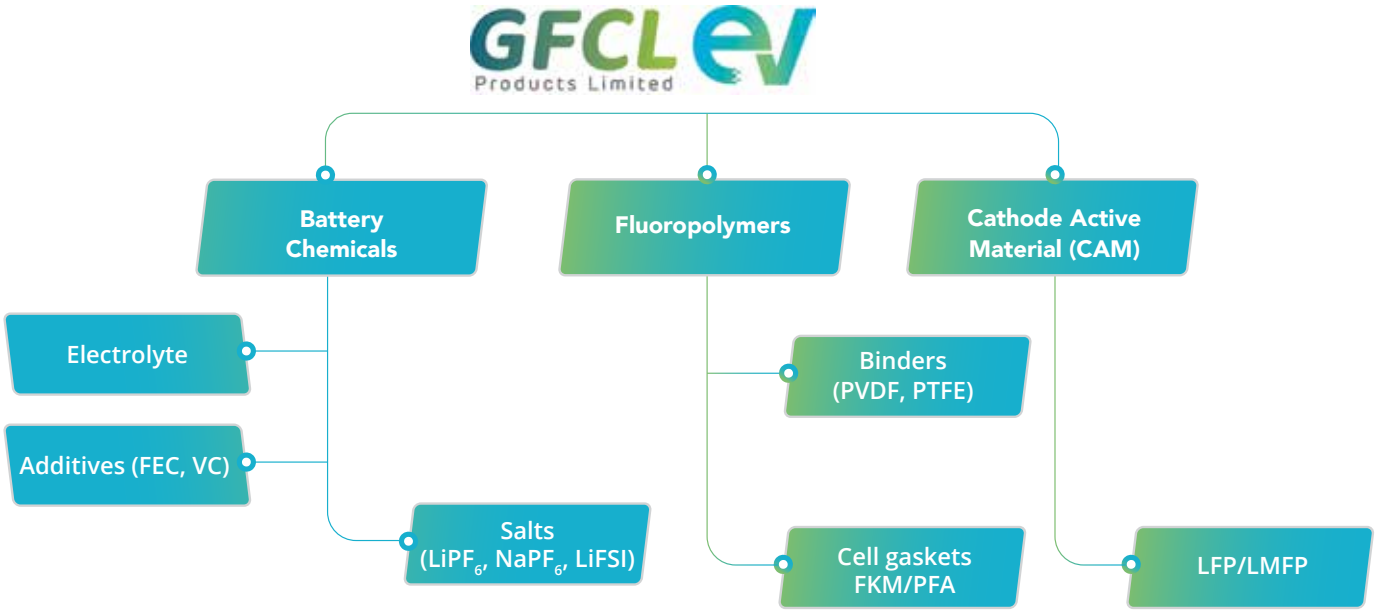
JOLVA, GUJARAT, INDIA

Battery Chemicals Manufacturing Plants

JT HILLS, MOROCCO

Fluorspar Mining & Beneficiation

GFCL EV – PRODUCT PORTFOLIO



- **PTFE for Dry Electrode process and PFA for cell gaskets offered by parent company Gujarat Fluorochemicals Limited**

Strong Value Proposition

- Widest portfolio of Lithium Ion Battery (LiB) chemicals covering >50% of a cell manufacturer's Bill of Materials
- Backward integration to natural minerals ensuring reliability & consistent supplies:
  - In-house AHF production for Fluoropolymers and Electrolyte salts
  - In-house $FePO_4$ production planned for LFP
  - Multiple monomer (TFE & VDF) plants for uninterrupted Fluoropolymer production
- Backward integration into Fluorspar mines secures supply of critical raw material
- Secured supply chain for other important raw materials leading to cost competitiveness
- In-house technology and large supporting infrastructure allowing for quick scale-up
- Strong legacy of Fluorine-based chemistries: critical capability for several LiB chemicals/materials.
- Sustainable and responsible manufacturing by use of non-Fluorinated polymerisation aids
- All products are in compliance to US IRA requirements
- USD 725 million investment committed over the next 4-5 years, for Battery Chemicals business including expansion of capacities.
- One of the top non-Chinese LiB materials suppliers with strong interest from large customers
- A capable leadership team with decades of experience across specialty chemicals domain

BATTERY CHEMICALS

Lithium Hexafluorophosphate ($LiPF_6$)

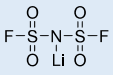
- Lithium Hexafluorophosphate ($LiPF_6$) is the conventional salt used to produce electrolytes for Lithium-ion Batteries (LiBs).
- $LiPF_6$-based electrolyte is suitable for all LiB chemistries such as LCO, LMO, NMC, NCA, LFP & LMFP that are used in applications like 3C digital devices and power tools, Electric Vehicles & Energy Storage Systems.
- GFCL EV offers $LiPF_6$ salt with good solubility, high purity and a higher degree of ion dissociation.

Chemical Name	Lithium Hexafluorophosphate
CAS Number	21324-40-3
Chemical Formula	$LiPF_6$
Structural Formula	
Molecular Weight	151.9
Appearance	Powder
Color	White
Density (g/cm^3)	1.5
Solubility	Soluble
Flash Point (°C)	25
Melting Point (°C)	200

Packaging Unit
SS Drum

Lithium Bis (fluorosulfonyl) Imide (LiFSI)

- Lithium Bis (fluorosulfonyl) Imide (LiFSI) is a white powder with high Lithium-ion conductivity.
- It has high chemical stability, thermal stability, hydrolytic stability, excellent low temperature performance, and environmental friendliness.
- It is considered an important electrolyte material in new energy materials such as lithium-ion batteries.
- LiFSI has higher conductivity and higher Li ion transference number than $LiPF_6$. It also shows better cycling performance and less Li plating after repeated fast charging cycles.
- Solid Electrolyte Interphase (SEI) formation in LiFSI is more homogeneous, flexible and with a lower resistivity compared to the SEI formed in $LiPF_6$.
- LiFSI has better compatibility with Silicon-based anodes.

Chemical Name	Lithium Bis (fluorosulfonyl) Imide
CAS Number	171611-11-3
Chemical Formula	LiFSI
Molecular Formula	$F_2LiNO_4S_2$
Structural Formula	
Molecular Weight	187.07
Appearance	Powder
Color	White
Density (g/cm^3)	1.052
Solubility	Soluble
Melting Point (°C)	140

Sodium Hexafluorophosphate ($NaPF_6$)

- Sodium Hexafluorophosphate ($NaPF_6$) is the salt used to produce electrolytes for Sodium-ion batteries (SiBs).
- SiBs represent a promising alternative to Li-ion systems.
- $NaPF_6$ also offers good solubility, high purity and a higher degree of ion dissociation, is suitable for various Sodium cell chemistries and can be used in EV and ESS applicants.

Chemical Name	Sodium Hexafluorophosphate
CAS Number	21324-39-0
Chemical Formula	$NaPF_6$
Structural Formula	
Molecular Weight	167.95
Appearance	Powder
Color	White
Density (g/cm^3)	2.4
Solubility	Soluble
Melting Point (°C)	200

Electrolyte Formulations

- Electrolyte formulations for LiBs and SiBs.
- Liquid electrolytes in LiBs and SiBs consist of salts, such as $LiPF_6$ and $NaPF_6$ in organic solvents.
- A liquid electrolyte acts as a conductive pathway for the movement of cations passing from the negative to the positive electrodes during discharge.
- GFCL EV offers various electrolyte formulations for Lithium and Sodium-ion batteries which allow ionic conduction over large temperature range, stabilise cathode and anode surfaces, extend battery lifespan, and improve cell performances and safety.
- Focussed on helping battery manufacturers commercialise ambitious new energy storage technologies.

Packaging Unit
SS Drum

Additives: Fluoroethylene Carbonate (FEC)

- Fluoroethylene Carbonate (FEC) is also a commonly used SEI formation additive, which is particularly used in the electrolytes of NMC batteries.
- FEC as an electrolyte additive can significantly alter the solvation structure, electrolyte reduction leading to enhanced electrochemical performance.
- FEC offers a simple and economical strategy to develop high-performance Lithium metal batteries in electrolytes.

Chemical Name	Fluoroethylene Carbonate
Other Name	4-Fluoro-1,3-dioxolan-2-one
CAS Number	114435-02-8
Chemical Formula	$C_3H_3FO_3$
Structural Formula	
Molecular Weight	106.05
Appearance	Liquid
Color	Colorless
Density (g/cm^3)	1.45
Boiling Point (°C)	212
Flash Point (°C)	102
Melting Point (°C)	18-23

Additives: Vinylene Carbonate (VC)

- Vinylene Carbonate (VC) is the most popular electrolyte additive used in Li-ion batteries, which helps to achieve excellent characteristics such as high energy density, long cycle life, high-rate performance, high safety, and is an essential part of Lithium battery electrolyte.
- Vinylene Carbonate (VC) is used in electrolytes of all types of battery chemistries.

Chemical Name	Vinylene Carbonate
Other Name	1,3-dioxol-2-one
CAS Number	872-36-6
Chemical Formula	$C_3H_2O_3$
Structural Formula	
Molecular Weight	86.05
Appearance	Liquid
Colour	Colourless or Light Yellow
Density (g/cm^3)	1.355
Boiling Point (°C)	178
Flash Point (°C)	73
Melting Point (°C)	22

FLUOROPOLYMERS

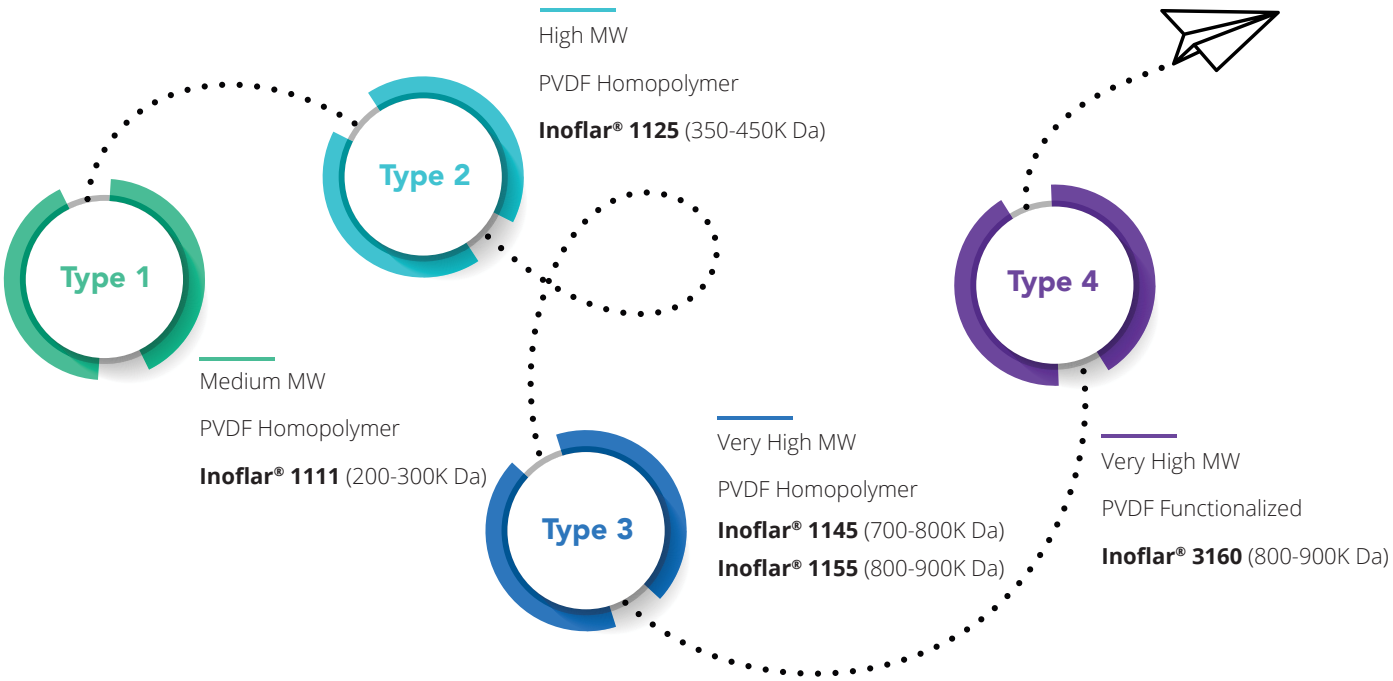
Inoflar® PVDF Binders

Portfolio to suit different cell chemistries

- **LFP, LMFP, LCO, NMC**
- **Wet & Dry Cathode**

Focus on

- **Low gelation**
- **Good dispersibility**
- **High adhesion**



FLUORO-SURFACTANT FS FREE

Inoflar® PVDF resins are manufactured without the use of Fluoro-surfactants

*Molecular weight data are obtained by Gel Permeation Chromatography in Dimethylacetamide (DMAC), calibrated using PMMA standards useful for a relative comparison.

INOFLON® PTFE FOR DRY ELECTRODE PROCESS

- Polymerized with emulsion polymerization technology for higher fibrillation characteristics
- Fibrillation facilitates binding of active material and provides required cohesion/adhesion
- PTFE allows substitution of solvent NMP (N-methyl-2-Pyrrolidone) used in conventional wet coating technology

INOFLON® PTFE FINE POWDER PORTFOLIO

INOFLON® PTFE Grade	SSG	Particle size (d_{50}) (µm)	Salient Features
FP7040EX	2.175	525	Produced using NFPA*
FP7040EXW	2.175	525	Produced using NFPA* Chemically stabilised for use as binder
GN7003	2.155	525	Very high molecular weight for better fibrillation
GN7150	2.175	525	Chemically stabilised for use as binder
GN7300	2.175	450	Chemically stabilised for use as binder

* Non-Fluorinated Polymerization Aids

SEALING SOLUTIONS

- Gaskets are used to electrically insulate the positive and negative terminal and provide sealing to ensure air and moisture from passing through the battery container.
- The gasket is present in a location exposed to the cell's internal and external environment.
- These gaskets are terminal can insulators and come into direct contact with the electrolyte. Hence, the gaskets must be chemically stable with electrolytes and resist creeping pressure. These are comprised of PFA/FKM material.

Inoflon® PFA

Excellent Chemical Resistance

High-Temperature Stability

Low Permeability

Superior Mechanical Strength

Electrical Insulation

Ease of Fabrication

Long Lifespan

PFA Grade	Melting Point (°C)	Melt Flow Rate (g/10 min)	Flex Life (Cycles)	Tensile Strength (MPa)	Elongation (%)
TEST METHOD	ASTM D 4591	ASTM D 1238	ASTM D 2176	ASTM D 3307	ASTM D 3307
PFA 8015HS	310	13	60000	25	300
PFA 8025HS	310	25	10000	25	275

Fluonox® FKM

Fluonox® FKM offers long-term durability, and chemical and electrochemical resistance under high temperatures and becomes an ideal choice of materials for cell gaskets, static & dynamic seals, and coolant transmission hoses in Li-ion battery systems. These FKM materials provide Li-Ion battery manufacturers with effective component design flexibility to help extend battery life and improve battery processing safety.

The other salient features of FKM include the following:

Excellent chemical and thermal resistance	Outstanding compression set resistance	Excellent permeation resistance	Outstanding weatherability

Press cure 10 min at 170°C (338F); Post cure 4 hours at 230°C (446F)

Grade	Mooney Viscosity Ml (1+10)' at 121°C	Fluorine Content (%)	100% Modulus MPa	Tensile Strength MPa	Elongation at Break %	Shore A Hardness
TEST METHOD	ASTM D 1646	Internal NMR method	ASTM D 412	ASTM D 412	ASTM D 412	ASTM D 2240
KR 520P	20	70.6	10	20	210	76 points

Compression Set: 70 hours at 200°C (392°F)

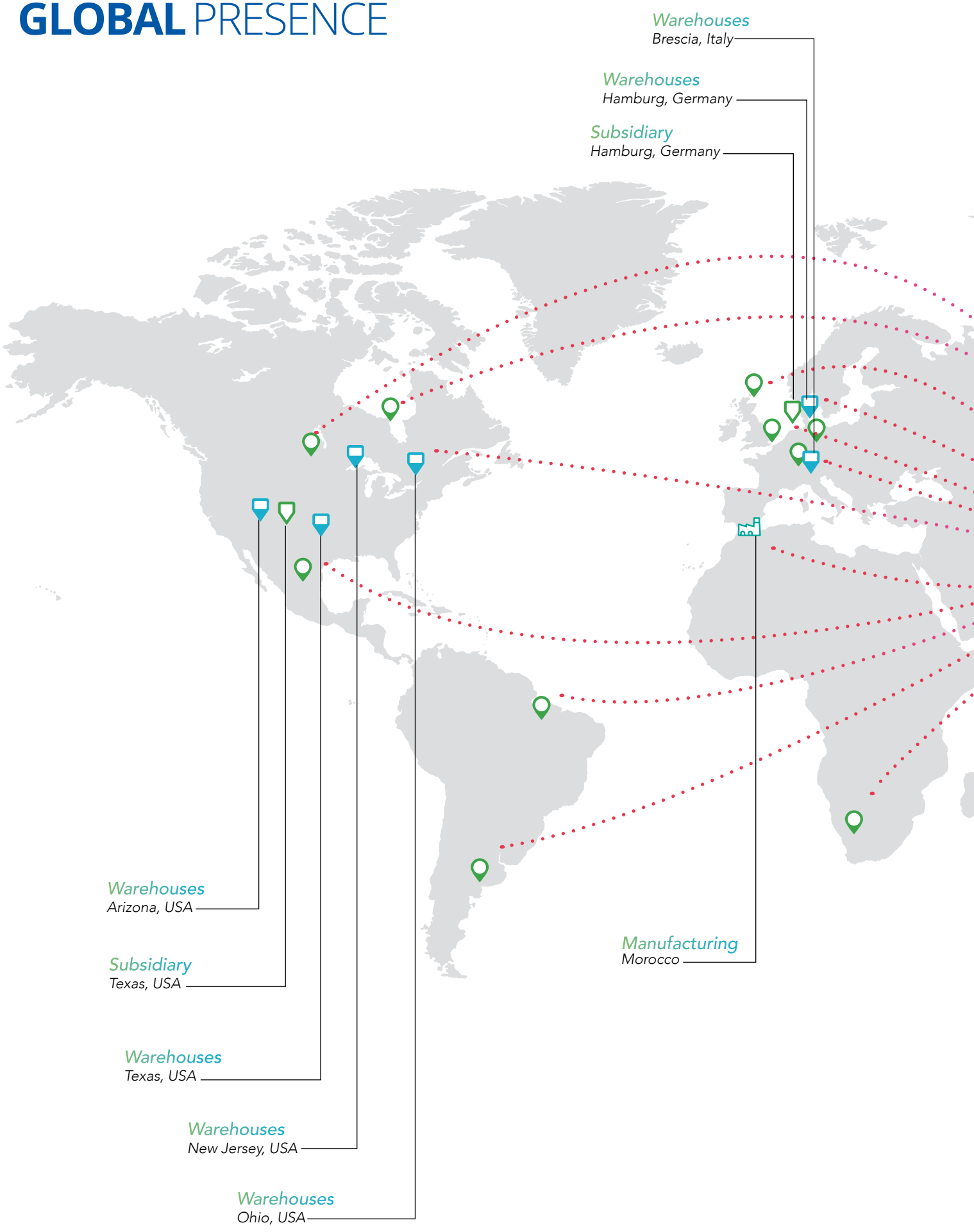
Properties	Value Unit %	Method
Compression Set	17	ASTM D395 Method B

CATHODE ACTIVE MATERIAL (CAM)

Lithium Iron Phosphate (LFP) Product Specifications

Properties	Reference	UOM	Process Capability
Appearance	Physical appearance of output material		Black powder, No lump
Specific Area	Specific Surface area SSA	m^2/gm	8 - 1.5
Particle Size	Particle size D10	µm	> = 0.41
	Particle size D50	µm	0.6-2.1
	Particle size D100	µm	< = 10
Density	Density - Tap	g/cm^3	0.8 - 0.9
	Density - Compact	g/cm^3	2.3 - 2.4
Elemental Composition	Carbon(C)	%	1.0 - 1.85
	Iron (Fe)	%	33.6 - 35.6
	Phosphorous (F)	%	18.5 - 20.5
	Lithium (Li)	%	4.2 - 4.6
Others	pH of 5% Dispersion in water		8 -10
Impurities	Calcium (Ca)	ppm	20
	Sodium (Na)	ppm	150
	Potassium (K)	ppm	50
	Magnesium (Mg)	ppm	50
	Copper (Cu)	ppm	5
	Moisture	ppm	< = 300
	Magnetic material	ppb	< 200
Performance characteristics @ 25°C			
Charge Discharge Characteristics	Initial specific discharge capacity @ 0.1C	mAh/G	> = 160
	Initial Coloumbic efficiency	%	97
	Specific capacity @ Charge/Discharge 0.5C/0.5C	mAh/G	141
	Specific capacity @ Charge/Discharge 1C/1C	mAh/G	135
	Specific capacity @ Charge/Discharge 1C/2C	mAh/G	130
	Specific capacity @ Charge/Discharge 1C/5C	mAh/G	96
Capacity Retention	Capacity Retention after 2000 Cycles @ 1C/1C	mAh/G	92
	Capacity Retention after 2000 Cycles @ 45 deg C @ 1C/1C	mAh/G	83
	No. of Cycles with 100% Depth of Discharge	Cycles	10000 - 11500

GLOBAL PRESENCE



Warehouses

Gujarat, India
Texas, USA
New Jersey, USA
Arizona, USA
Ohio, USA
Hamburg, Germany
Brescia, Italy

Corporate HQ

Noida, India

Subsidiary

Hamburg, Germany
Texas, USA

Manufacturing

Dahej, Gujarat, India
Ranjitnagar, Gujarat, India
Morocco

Sales & Distribution

Americas: Michigan, Philadelphia, Atlanta, New Jersey, Mexico, Brazil and Argentina

EU: Italy and Germany

ROW: India, South Africa, Thailand, China, Korea, Taiwan, and Japan

INOXGFL GROUP
BEYOND INFINITY

CORPORATE HQ

GUJARAT FLUOROCHEMICALS LIMITED | GFCL EV PRODUCTS LIMITED

INOXGFL TOWERS,17, SECTOR-16A, NOIDA-201301 U.P, INDIA | +91-120-6149600 | WWW.GFL.CO.IN | E : INFO@GFL.CO.IN

WORKS

PLOT NO D-2/CH/173 & 222, VILLAGE – JOLVA, GIDC INDUSTRIAL ESTATE, DAHEJ II, DAHEJ, DISTT - BHARUCH, GUJARAT, INDIA

CONTACT@GFCLEV.CO.IN | WWW.GFCLEV.CO.IN

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