

# INOFLAR<sup>®</sup> PVDF

SUSTAINABLE ENGINEERING FOR  
HIGH PERFORMANCE APPLICATIONS



Inoflar<sup>®</sup> PVDF resins are manufactured  
without the use of Fluoro-surfactants



An **INOXGFL** Group Company  
BEYOND INFINITY



## ABOUT THE COMPANY

**Gujarat Fluorochemicals Limited (GFL), is a part of the INOXGFL Group - an Indian Conglomerate with a legacy of more than 90 years. The group has diversified business segments comprising of Fluoropolymers, Speciality Chemicals, Wind Energy, and Renewables.**

GFL is a leading producer of Fluoropolymers, Fluoro specialities, Refrigerants and Chemicals for applications in varied industries. GFL derives its strength from expertise in Fluorine Chemistry, vertical integration from natural minerals to Fluoropolymers and strong R&D, enabling us to provide one of the best quality products meeting all regulatory compliances, to our clientele globally. GFL started with India's largest Refrigerant manufacturing unit at Ranjitnagar, Gujarat, India. Foraying into new avenues in 2007, with one of the world's most integrated facilities at Dahej, Gujarat, India, GFL now has a diverse portfolio of Fluoropolymers comprising PTFE, PFA, FKM, PVDF and Fluoropolymer Additives. By setting up capacities for

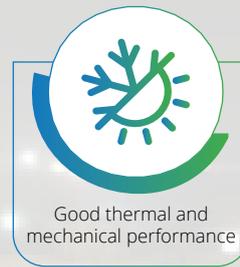
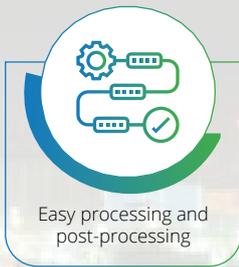
materials (Fluoropolymers and Speciality Chemicals) catering to new growth sectors, the group is extending its reach into EVs, Solar Energy, and Hydrogen Fuel Cells. Several capacities are being set up at GFL including those for PVDF used as cathode binders in EV batteries, chemicals for EV batteries, and membranes for Hydrogen Electrolysers.

With three manufacturing facilities in India, a captive Fluorspar mine in Morocco, offices and warehouses in Europe and USA, and a marketing network spread across the world, GFL is one of the most established players in Fluoropolymers and Fluorospecialities markets globally.

# INOFLAR®

## POLYVINYLIDENE FLUORIDE (PVDF)

Inoflar® PVDF is a partially-Fluorinated semi-crystalline polymer with exceptional thermo-mechanical and chemical properties and offers excellent abrasion and UV resistance. Hence, PVDF is the preferred material of choice in many specialty applications such as oil and gas, semiconductors, membranes for water filtration, chemical process industry, architectural coatings, binders for Lithium-ion cells and photovoltaics.





## INOFLAR® PVDF PELLETS

Inoflar® PVDF resins exhibit exceptional mechanical performance and abrasion resistance, high thermal resistance and low permeability along with very good chemical resistance inherent to Fluoropolymers, making them an ideal choice for contact surface material for corrosive fluids. Inoflar® pellet grades are melt processable PVDF resins with excellent processability and can be processed using conventional equipment used for commodity polymers like Polyolefins. Inoflar® pellet grades are widely used for manufacturing of piping system components such as pumps, valves, fittings and pipes. They are also used for manufacturing of sheets for lining of vessels and tanks, tower packing, filaments and films.

Standard processing temperatures of Inoflar® pellet grades mostly do not exceed 250 °C and are safe to process as the decomposition temperatures are > 350 °C. Inoflar® PVDF pellets are hydrophobic and pre-drying is generally not required unless exposed to highly humid environments. With their lower melt viscosities, Inoflar® 1005 and Inoflar® 1011 are generally more suitable for injection moulding, whereas Inoflar® 1017 & Inoflar® 1020 are preferred for extrusion, but are also suitable for injection moulding.



Easy processing and post-processing



Excellent chemical resistance



Excellent heat and UV resistance



Excellent mechanical strength and abrasion resistance

# INOFLAR™ PVDF PELLETS

Inoflar™ Grade	Melting Point	Melt Viscosity	Melt Flow Rate	MFR Load	Process				Typical Uses
	(ASTM D3418)	(ASTM D3835)	(ASTM D1238)		Compression Moulding	Transfer Moulding	Injection Moulding	Extrusion	
	°C	K Poise	g/10 min	kg					
1005	165 – 172	4 – 8	16 – 30	5		✓	✓	✓	Pumps, Valves, Fittings, Tower Packings, Films
1011	165 – 172	8 – 12	8 – 16	5		✓	✓	✓	Pumps, Valves, Fittings, Films, Filaments
1017	165 – 172	12–18	3 – 8	5	✓	✓	✓	✓	Pressure Pipes, Sheets, Stock Shapes, Pumps, Valves, Filaments
1020	165 – 172	18 – 23	1.5 – 3	5	✓	✓	✓	✓	Pressure Pipes, Rods, Stock Shapes, Sheets, Filaments

## Inoflar™ PVDF Pellets

Inoflar™ Grade		1005	1011	1017	1020	
Property	Unit	Value	Value	Value	Value	Method
Specific Gravity		1.76 – 1.79	1.76 – 1.79	1.76 – 1.79	1.76 – 1.79	ASTM D792
Water Absorption	%	< 0.04	< 0.04	< 0.04	< 0.04	ASTM D570
Melt Mass Flow Rate <sup>(230 °C, 5 Kg Load)</sup>	g/10min	16 – 30	8 – 16	3 – 8	1.5 – 3	ASTM D1238
Molding Shrinkage - Flow	%	< 3	< 3	< 3	< 3	Internal Method
Tensile Modulus	MPa	1400 – 2300	1400 – 2300	1400 – 2300	1400 – 2300	ASTM D638
Tensile Strength <sup>(Yield)</sup>	MPa	45 – 55	45 – 55	45 – 55	45 – 55	ASTM D638
Tensile Strength <sup>(Break)</sup>	MPa	35 – 50	35 – 50	35 – 50	35 – 50	ASTM D638
Tensile Elongation <sup>(Yield)</sup>	%	5 – 10	5 – 10	5 – 10	5 – 10	ASTM D638
Tensile Elongation <sup>(Break)</sup>	%	> 20	> 20	> 20	> 20	ASTM D638
Taber Abrasion Resistance <sup>(1000 cycles, 1000 g, CS-17 Wheel)</sup>	mg	5 – 10	5 – 10	5 – 10	5 – 10	ASTM D4060
Flexural Modulus <sup>(23 °C)</sup>	MPa	1400 – 2300	1400 – 2300	1400 – 2300	1400 – 2300	ASTM D790
Compressive Strength <sup>(23 °C)</sup>	MPa	65 – 100	65 – 100	65 – 100	65 – 100	ASTM D695
Durometer Hardness <sup>(Shore D, 1 sec, 2,00 mm)</sup>		73 – 80	73 – 80	73 – 80	73 – 80	ASTM D2240
Glass Transition Temperature	°C	-40	-40	-40	-40	ASTM D4065
Melting Temperature	°C	165 – 172	165 – 172	165 – 172	165 – 172	ASTM D3418
Deflection Temperature under load <sup>(1.80 Mpa)</sup>	°C	105 – 110	105 – 110	105 – 110	105 – 110	ASTM D648
Deflection Temperature under load <sup>(0.45 Mpa)</sup>	°C	125 – 140	125 – 140	125 – 140	125 – 140	ASTM D648
Vicat Softening Temperature	°C	140	140	140	140	ASTM D1525
Thermal Stability <sup>(1% Weight loss in Air)</sup>	°C	> 375	> 375	> 375	> 375	TGA
Volume Resistivity	Ohm-m	1 × 10 <sup>12</sup>	ASTM D257			
Dielectric Strength <sup>(23 °C, 1.00 mm)</sup>	kV/mm	20 – 25	20 – 25	20 – 25	20 – 25	ASTM D149
Oxygen Index	%	> 44	> 44	> 44	> 44	ASTM D2863

# INOFLAR® PVDF POWDER

Inoflar® PVDF powders are easily solvable in polar solvents such as NMP and are excellent material of choice for applications such as binders for Lithium-ion batteries and filtration membranes.

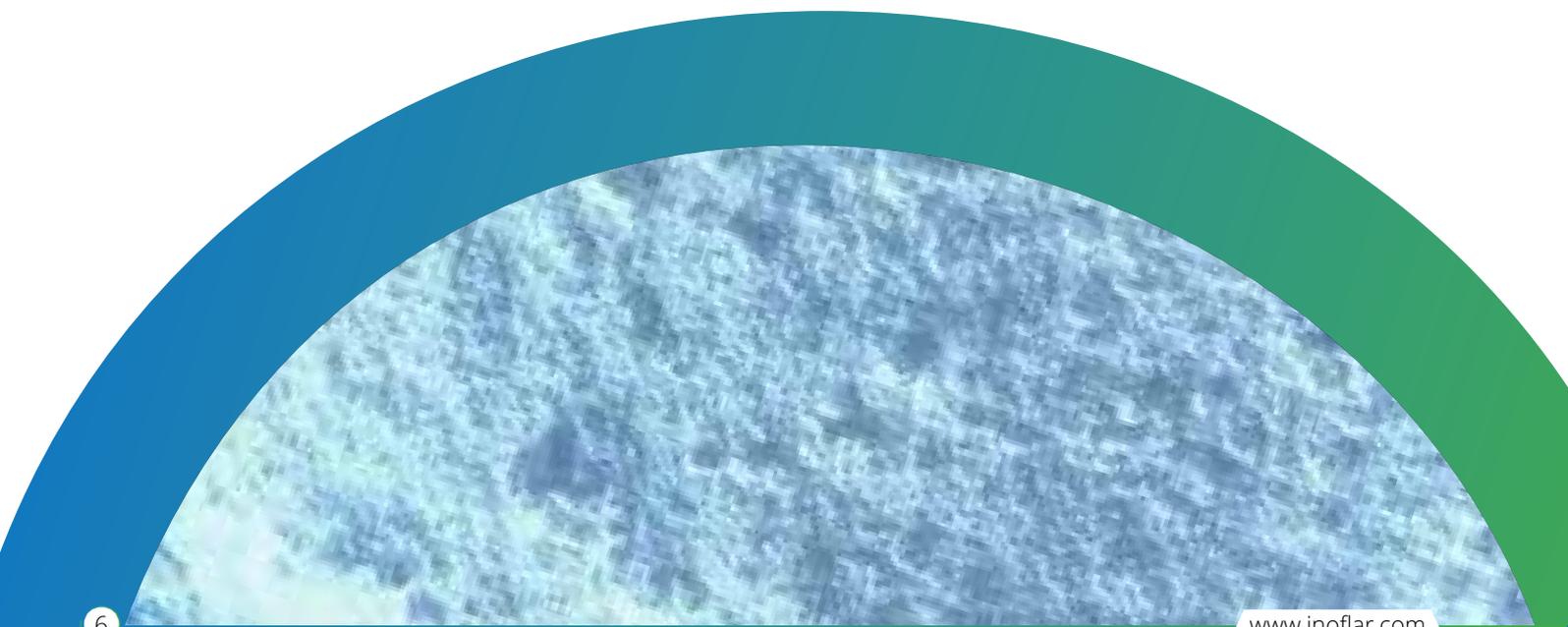
The higher surface area to volume ratio of Inoflar® PVDF powder aids easier and faster dissolution of PVDF in solvents.

Inoflar® PVDF powder resins dissolve with comparative ease in the following solvents:

Active solvents		Latent solvents
Solubility ≈ 5 - 10% (w/w) @ 25 °C		Solubility < 1% (w/w) @ 25 °C
N-methylpyrrolidone (NMP)	Tetramethyl Urea	Acetone
Dimethylacetamide (DMAC)	Dimethyl Sulfoxide (DMSO)	Tetrahydrofuran
Dimethylformamide (DMF)	Trimethyl Phosphate	Methyl Ethyl Ketone

## Applications of Inoflar® PVDF Powder

Inoflar® PVDF GRADE	APPLICATION
1125	Flat Sheet Membranes
1135	Hollow Fiber and Tubular Membranes
5125	Coating
1150	Battery Binder
3160	Battery Binder





# INOFLAR™ PVDF RESINS FOR MEMBRANE

INOFLAR™ PVDF resins have exceptional chemical resistance, mechanical strength and durability—making it a choice of material for manufacturing membranes, which are to be exposed in brackish and corrosive environments such as industrial wastewater treatment compared to material like cellulose acetate, PP, PES and PESU media. INOFLAR™ PVDF resins have excellent chemical resistance to harsh chemicals such as chlorine, bromine, hydrogen peroxide, ozone, alcohols, sodium hypochlorite, chlorine dioxide, inorganic acids, and organic acids, which reduces the lifecycle costs and breakage of membranes during cleaning operations.

INOFLAR™ PVDF resins for membrane are NSF-61, USP Class VI certified, allowing them to be used in bio-medical, food and water contact applications.

INOFLAR™ PVDF resins are available in powder form and are readily soluble in polar solvents NMP, DMAC and DMF making processing easy by phase-inversion. High viscosity ensures easy spinning operations by NIPS and TIPS. A variety of configurations such as hollow-fibre, tubular and flat sheet membranes are possible for MBR, UF and MF filtration applications.

Grade	Form	Melting Point (ASTM D3418) °C	Melt Viscosity (ASTM D3835) K Poise	Melt Flow Rate (ASTM D1238) g/10 min	MFR Load kg	Application		Typical Uses
						NIPS	TIPS	
INOFLAR™ 1125	Powder	165-172	N/A in TDS	2-6	12.5	✓	✓	Flat Sheet Membranes
INOFLAR™ 1135	Powder	160-165	N/A in TDS	2-6	21.6	✓	✓	Hollow Fiber & Tubular Membranes



# INOFLAR™ PVDF RESINS FOR COATINGS

Inoflar™ 5125 resin is a high molecular weight homopolymer of Vinylidene Fluoride used as the base resin in long-life coatings for Aluminum, Galvanised Steel, and Aluminised Steel. Applications include metal roofing and siding, window and door frames, curtain wall and other miscellaneous metal trim and components.

Inoflar™ 5125 powders exhibit excellent resistance to UV, dirt and mildew. They offer superior weatherability characteristics and are suitable for both solvents based and non-solvent based coating formulations and should impart longevity and greater colour retention to the coated substrates.

## Inoflar™ 5125 PVDF for Coatings

Property	Unit	Value	Method
Water Absorption	%	< 0.04	ASTM D570
Moisture	%	< 0.5	Internal
Melt Flow Rate (230 °C; 12.5 kg load)	g/10min	2 - 6	ASTM D1238
Melting Temperature	°C	165 - 170	ASTM D3418
Gloss		> 25	ASTM D523

# INOFLAR™ RESINS FOR LITHIUM-ION BATTERIES

Li-ion batteries have dominated the portable electronic industry for almost two decades now. These batteries are known for offering almost unmatched volumetric energy densities and are now also powering zero-emission electric vehicles and plug-in hybrid electric vehicles.

INOFLAR™ PVDF resins are exceptionally pure and free of any additives or ionic impurities that can interfere with electrochemical reactions. These are high molecular weight fluoropolymers that offer good adhesion and binding properties. Due to their excellent thermal and chemical resistance, they are the preferred binder for lithium-ion battery application.

Lithium batteries demand long-term reliability as well as chemical and electrochemical resistance in the specific chemical environment of Li-ion cells. PVDF is electrochemically stable in the full range of voltage between 0 and 5V vs Li+/Li. Also, PVDF resins have a melting point >156°C and no thermal degradation occurs before 420°C for short-term treatments. This guarantees its safe use in the electrochemical environment of the lithium cell. INOFLAR™ PVDF resins also have high crystallinity levels, which in turn offers high resistance in typical electrolytes used in Lithium Batteries.

INOFLAR™ PVDF resins have excellent solubility in polar solvents like NMP and are compatible with all cell chemistries and upcoming sodium-based chemistry.

INOFLAR™ Grade		Molecular Weight	Melting Point (ASTM D3418)	Solution Viscosity (7% PVDF in NMP, 100s-1) (Internal Method)
			°C	cP
1150	Homopolymer	> 700k Da	158-165	900-1200
3160	Homopolymer/Modified homopolymer	> 700k Da	158-165	1100-1500



# RESEARCH & DEVELOPMENT

## GFRC

Gujarat Fluoropolymers Research Center (GFRC) located at Dahej, India, is at the forefront of product and application development activities and serves as an essential bridge between market requirements and manufacturing operations. It focuses on offering genuine expertise and prompt customer support on Inoflar® products.

GFRC, a team of research scientists and product specialists, is equipped with state-of-the-art application development laboratory including DCS operated pilot reactors. It has collaborated with renowned research institutes globally to work on the areas of new product development and sustainable manufacturing technologies. With this, the centre focuses on delivering customised Fluoropolymer products for novel applications and on developing manufacturing technologies, which have minimal impact on the environment, thereby ensuring a sustainable future for the next generation.

## Core functions of GFRC

Customer Support	Production Support	Quality Support
Technical Service	Product Development	Functional Testing
Records and Citations	Process Optimization	Certifications and Regulatory Compliances
Pre-sales Documentation	Analytical Support	Statistical Analysis and Control
Development of Processing Guidelines		Customer On-site Audits
Application Development		Customer Feedback Analysis
Product Literature		Compliance to Quality Agreements

# REGULATORY COMPLIANCE

GFL is committed to “Green Chemistry” and offers environment-friendly products using sustainable technologies. Our extensive research and development in the field of Fluoropolymers enable us to comply with all major global regulations and facilitate our customers to choose greener products manufactured by sustainable technologies.



REACH - Registration, Evaluation, Authorization and Restriction of Chemicals



NSF International- National Sanitation Foundation



EC 1935/2004 - European Commission



EC 10/2011 - European Commission



ROHS - Restriction of Hazardous Substances



FDA - Food and Drug Administration



USP Class VI - United States Pharmacopeia



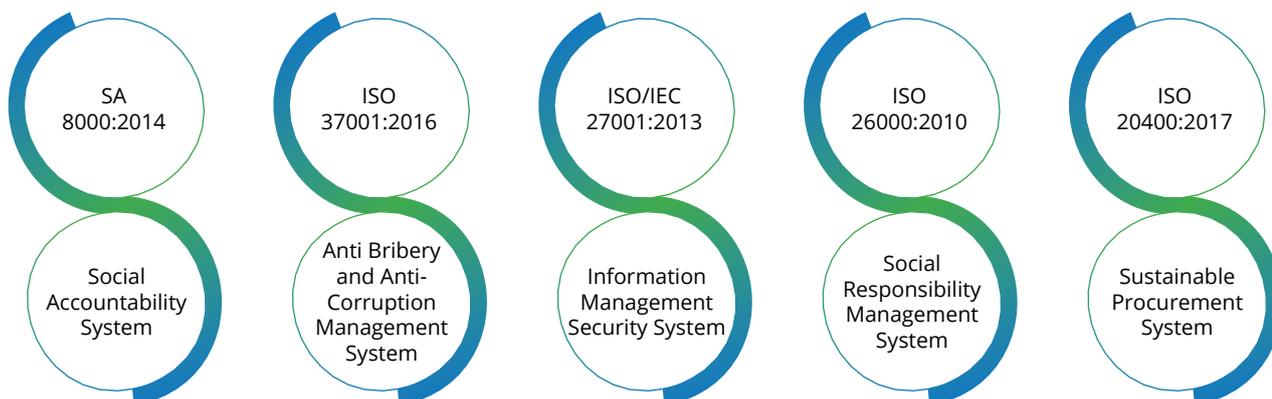
UL- Underwriter laboratory

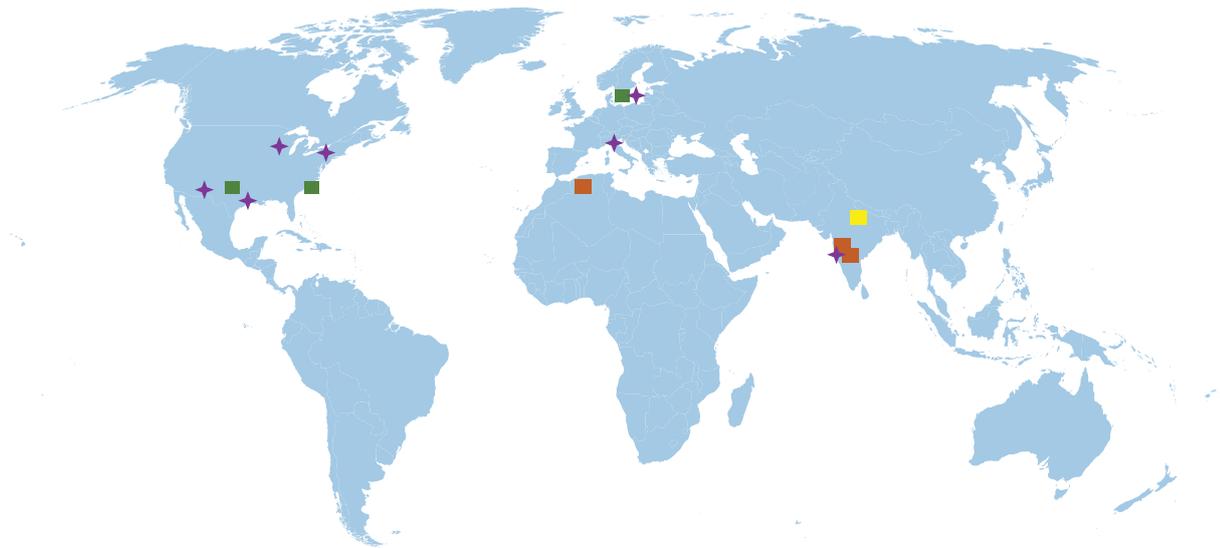


SVHC - Substances of Very High Concern

# SUSTAINABILITY

GFL is committed to social, environmental and economic sustainability through responsible processes, practices and greener initiatives not only in our products but also in our principles. While consistent operating results and strong financial performance are a business imperative, pursuing success while keeping Health and Safety paramount, remains one of our enduring values. The Company measures the impact of its business operations through the 3 key pillars of sustainability, namely People, Planet & Profit.





#### Corporate HQ

Noida, India

#### Warehouses

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

#### Subsidiary

Hamburg, Germany  
Texas, USA

#### Manufacturing

Dahej, Gujarat, India  
Ranjit Nagar, Gujarat, India  
Morocco, South Africa

#### Sales & Distribution

North America  
South America  
Europe  
Middle East, Africa  
Asia Pacific

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