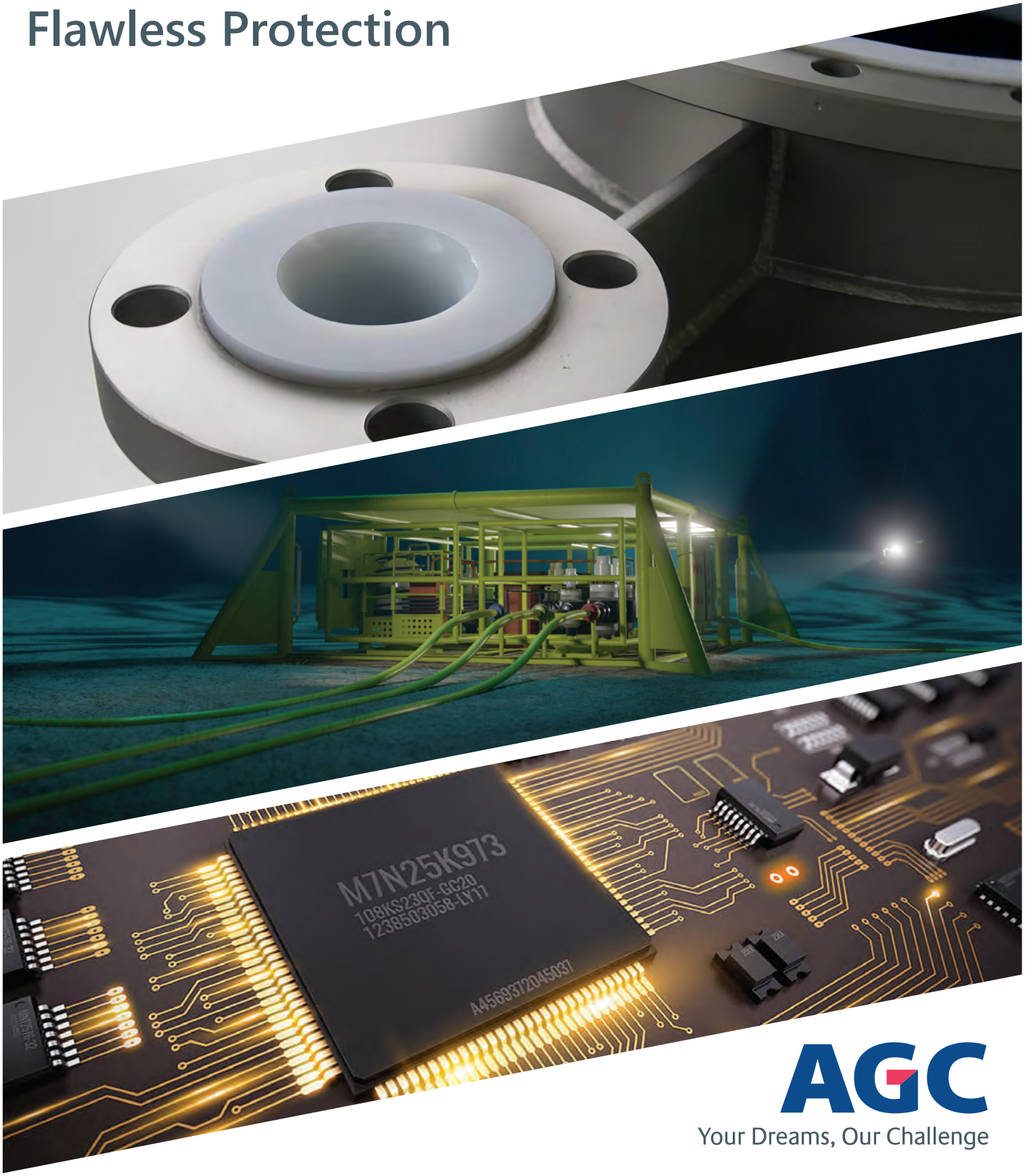
Fluon®

Powder Coatings for Flawless Protection



AGC

Your Dreams, Our Challenge

Chemical processes in industrial settings can be extremely harsh, often leading to premature deterioration of equipment such as vessels, pipework, pumps, and valves. However, the need for frequent maintenance and replacement can be significantly minimised by applying our advanced protective coatings to safeguard equipment exposed to corrosive fluids, gases and fumes.

Unmatched Durability with Fluoropolymer Coatings

Our Fluon® and Fluon+™ powder grades offer unparalleled chemical resistance and barrier properties, even in the demanding conditions of the chemical process industries. These coatings not only provide exceptional protection but also allow for contamination-free manufacturing, particularly in sensitive sectors like life sciences and semiconductor manufacturing where purity is paramount.

Tailored Solutions for Enhanced Performance

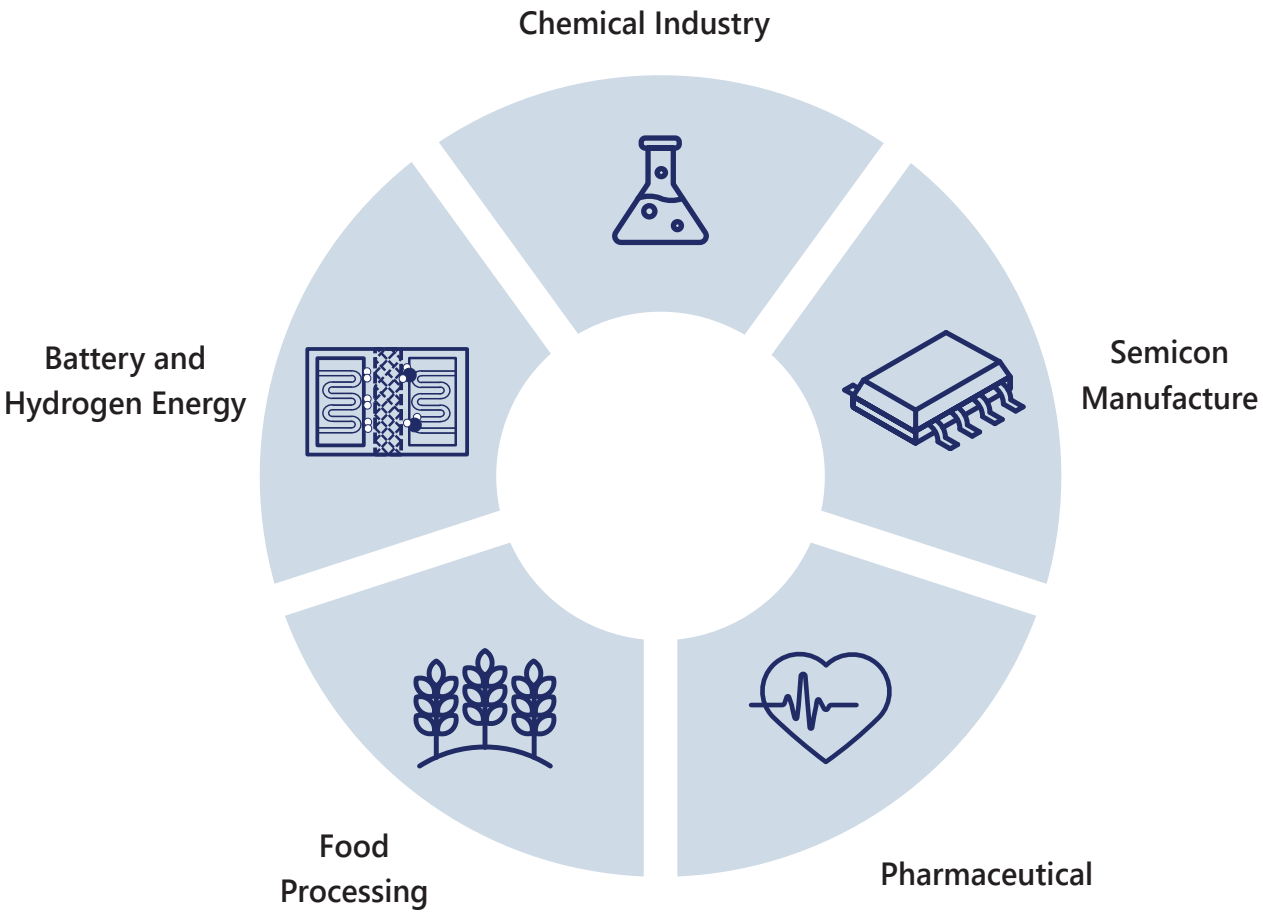
From long-lasting chemical resistance to non-stick performance and low permeability, our coatings offer a multitude of benefits for diverse applications, ensuring consistent performance and prolonged equipment lifetime.

Features

- Chemical and abrasion resistance
- Seamless coating
- UL94 V-0 and LOI approx. 32
- Non-stick
- Low permeability
- Primerless adhesion on metal
- FDA approved
- Factory Mutual (FM) compliance

Benefits

- Enhanced lifetime and lower maintenance
- No weak points against chemical attack
- Naturally low flammability
- Easy to clean, less downtime
- Consistent performance on complex geometries
- Easier manufacturing process
- Food contact safety
- Ideal for semiconductor cleanroom applications



Fluon® ETFE (ethylene tetrafluoroethylene) is a partially fluorinated copolymer that offers outstanding corrosion resistance, chemical inertness and mechanical toughness over a wide temperature range. Mechanical and electrical properties are maintained during continuous operation to temperatures ranging from -200°C up to +150°C with no breakage by impact at room temperature. ETFE also offers low smoke and flame characteristics - it is rated 94V-0 by UL.

The combination of electrical, thermal and mechanical properties possessed by ETFE has earned it a wide range of applications globally, from high-performance cable insulation to ultra-durable architectural film to seamless linings for chemical tanks and manifolds.

Fluon® PFA, a copolymer of perfluoroalkoxy ethylene and tetrafluoroethylene, is fully fluorinated and as a result, possesses exceptional chemical resistance and electrical insulation properties up to temperatures of +260°C. Owing to its fully fluorinated nature, PFA also has a limiting oxygen index (LOI) of 95%, preventing the spread of fire.

PFA is used in a variety of applications. Because it is melt-processable, it is an ideal material for situations where the unmatched chemical and thermal resistance of PTFE are required but where the ease and convenience of continuous processing are preferred – these include high voltage cables, high purity injection moulded components, tubes for conveying aggressive fluids and pump and valve linings.

Both Fluon® ETFE and PFA are available in powder form, for rotolining and electrostatic spray coating processes. Enhanced variations on these grades are available to provide additional benefits depending on your specific needs.

	Units	PTFE	PFA	ETFE	ECTFE
Melting Point	°C	327	305	260	242
Specific Gravity		2.16	2.15	1.73	1.68
Mechanical Properties					
Tensile Strength	MPa	20 - 39	32 - 39	40 - 54	40 - 57
Elongation	%	230 - 600	340 - 400	350 - 450	250 - 300
Flexural Modulus	MPa	400 - 600	530 - 630	850 - 1000	1600 - 1800
Impact Strength @ 23°C	J/m	180	no break	no break	no break
Thermal and Flame Resistance					
Upper Service Temperature (20,000h)	°C	260	260	150	150
UL64 Flame Rating		V-0	V-0	V-0	V-0
Limiting Oxygen Index	%	> 95	> 95	30 - 45	> 52
Electrical Performance					
Dielectric Constant @ 1MHz		2.1	2.1	2.6	2.6
Dissipation Factor @ 1MHz		< 0.0001	0.0001	< 0.0007	< 0.015
Arc Resistance	s	> 300	> 180	122	50
Volume Resistivity	ohm.cm	$> 10^{18}$	$> 10^{18}$	$> 10^{17}$	$> 10^{15}$
Surface Resistivity	ohm.cm	$> 10^{18}$	$> 10^{17}$	$> 10^{15}$	$> 10^{14}$

Electrostatic Spray Coating is a state of the art method of powder coating, using air under pressure to direct charged particles to a conductive substrate, typically a stainless steel part. It is a useful coating technique when employed to parts with complex geometries, where a sheet coating might leave seams or weak points.

After applying the powder, parts are sintered to provide an impermeable polymer, providing durable protection resulting in reduced maintenance needs.

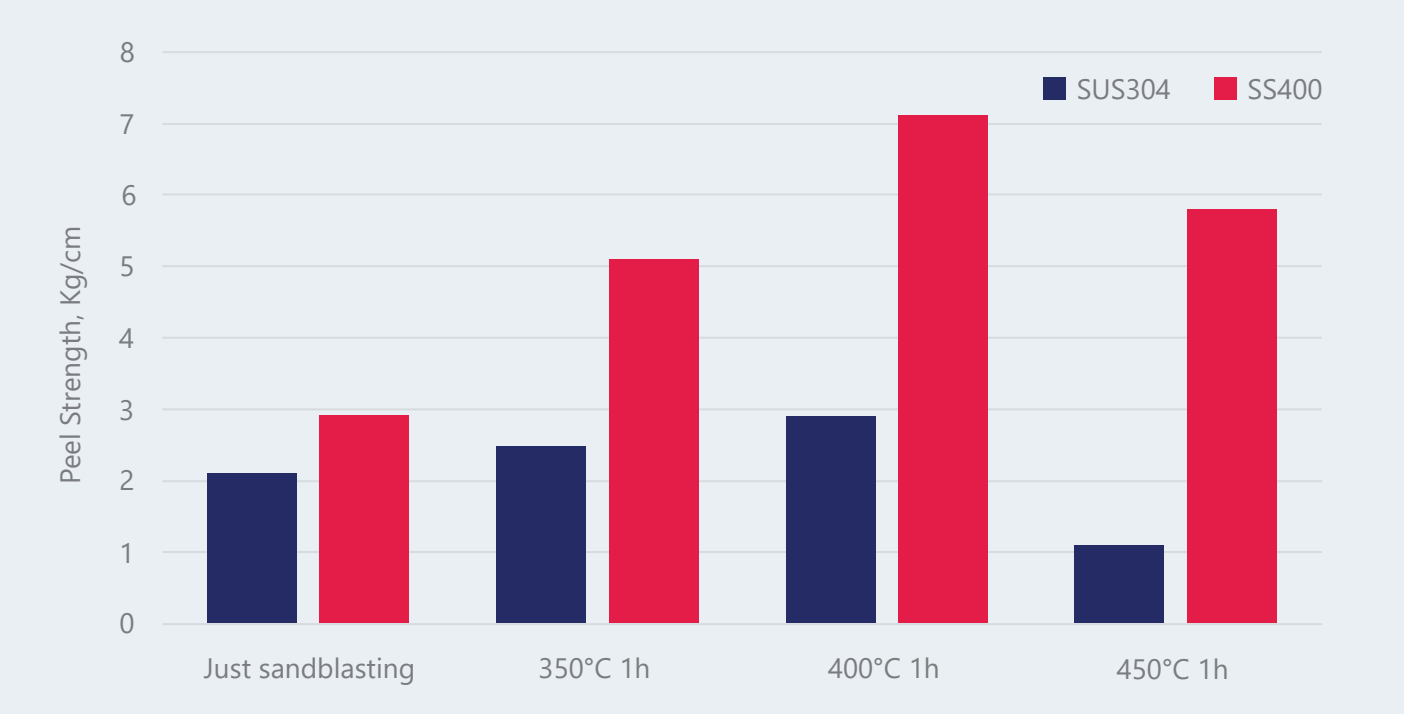
Fluon® Electrostatic Spray Coating Grades

	Type	Melting Point (°C)	MFR (g/10min)	Particle Size (µm)	Application Thickness	Notes	FDA
Z-8820X	ETFE	260	7 - 14	20 - 30	50 - 200 µm		✓
TL-081	ETFE	260	18 - 25	50 - 150	up to 900 µm	Can be used for FM ducting top coat	✓
LM-2150	LM-ETFE	225	13 - 21	80 - 100	up to 900 µm	Glossier finish	✓
ZL-520N	ETFE	260	5 - 11	70 - 80	200 - 800 µm	20% carbon fibre	×
ZL-521N	ETFE	260	5 - 11	50 - 60	Topcoat for ZL-520N	5% carbon fibre	×
CP-801XGN	Green ETFE	260	7 - 10	50 - 150	up to 800 µm	For FM ducting, base coat	×
EA-2000 PW10	PFA	298	10 - 14	2 - 3	50 - 200 µm	Enhanced adhesion	×

Impact of Heat Oxidation on Peel Strength

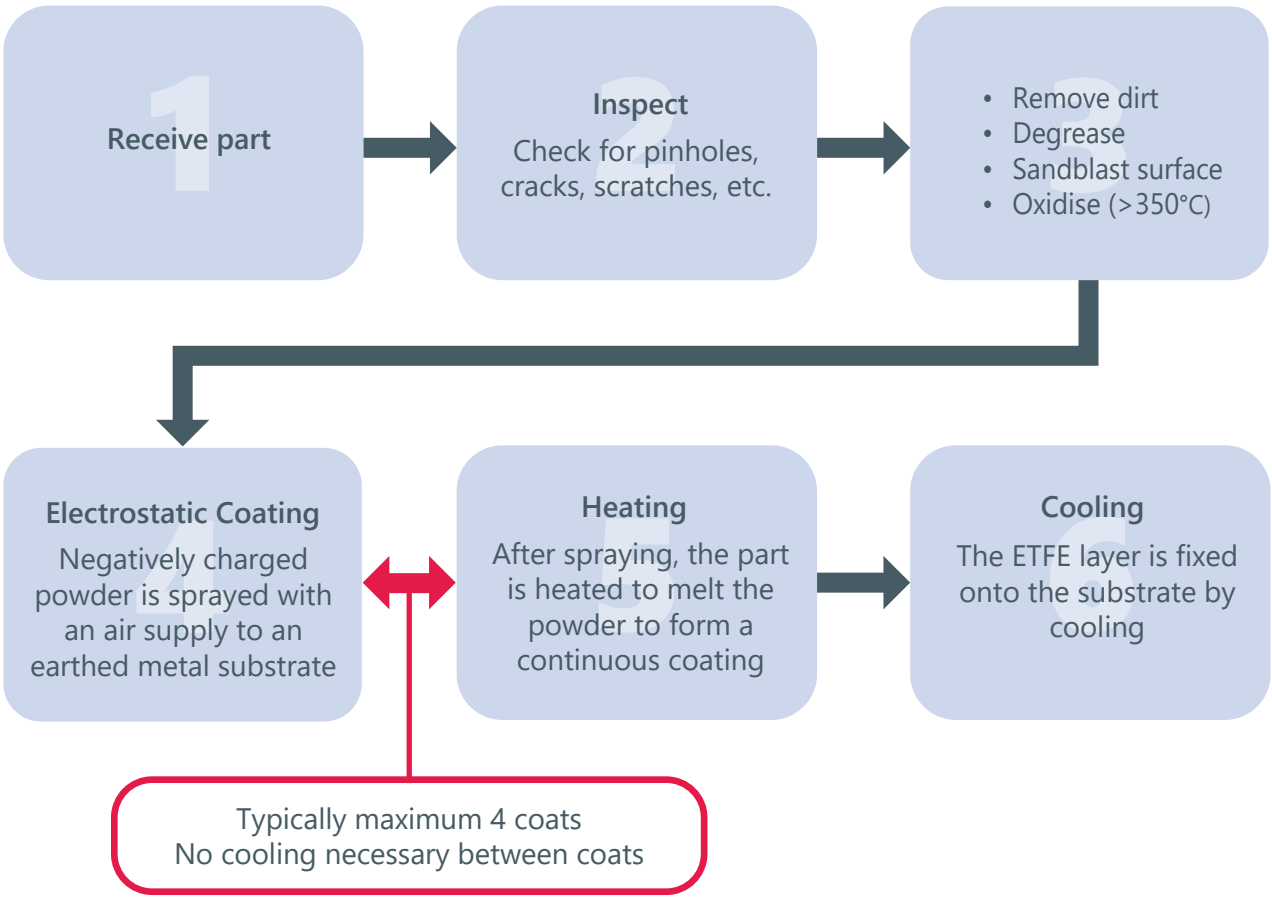
Fluon® ETFE gives naturally good adhesion to certain metals, including stainless steel, where the surface has been prepared appropriately, without the need for a primer*. After cleaning and degreasing the substrate, sandblasting should be followed by heat oxidation. This activates the surface of the metal to allow enhanced physical bonding of ETFE to the substrate. One hour at 350°C to 400°C is recommended to provide sufficient oxidation to enable a peel-resistant coating of Fluon® ETFE to be achieved.

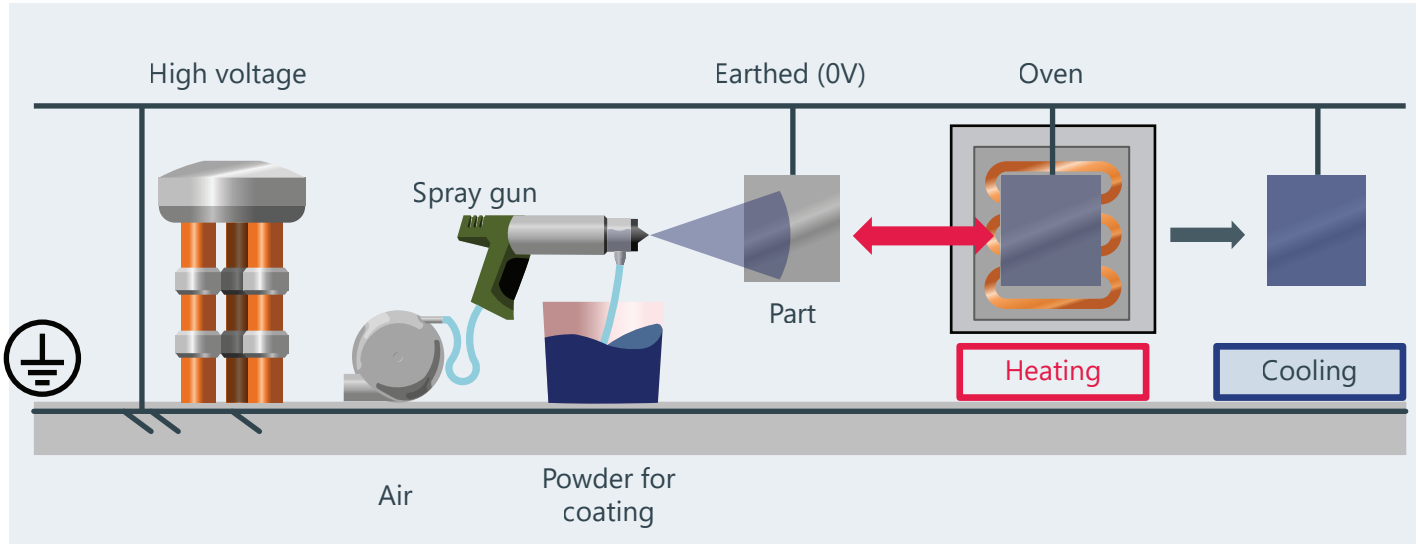
** Fluon® LM-ETFE grades, such as LM-2150, the use of a primer is recommended.*



Comparison of effect of heat oxidation at various temperatures versus no heat oxidation on the peel strength of coated parts as a measure of adhesion strength for SUS304 and SS400 substrates.

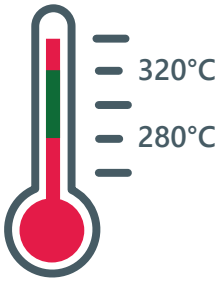
Outline Process





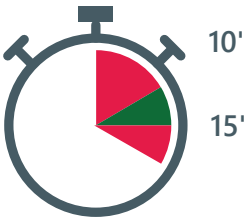
Bake temperature

- Start at 280°C, depending on the grade
- Increase only if necessary



Bake time

- No longer than 15 minutes per coat
- Four coats maximum recommended



Rotolining is a method of powder coating, using heat to melt the polymer powder and rotation through one or more axes to allow the polymer to flow and coat all surfaces evenly. It is a method typically employed on parts with complex internal geometries where a seamless surface is critical and where thicker coatings are required than could be achieved by spray coating.

Rotolining complex parts requires a large oven to house the equipment required for multi-axis rotation.

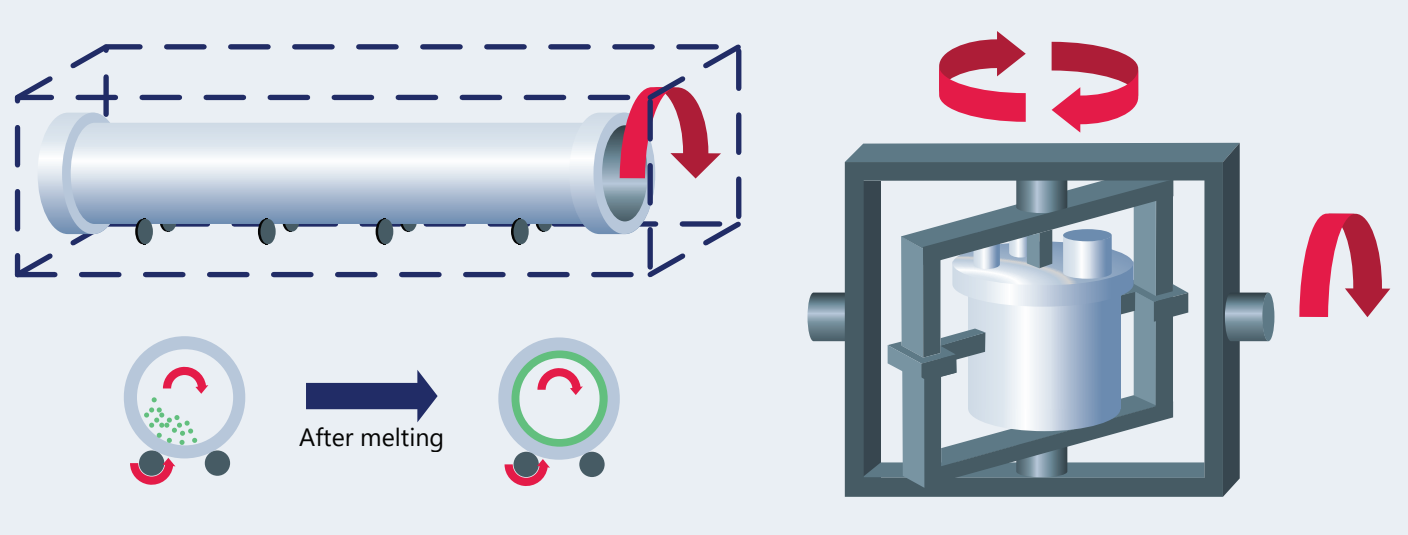
Rotomoulding is similar to rotolining, but uses a release agent to remove the final part from a mould. Parts that might be considered to have complex geometries include:

- Vessels
- Tanks
- Pipework
- Tubes
- Elbow joints
- Manifolds
- Pump Casings

Rotomoulding and Rotolining Grades

	Type	Melting Point (°C)	MFR (g/10min)	Particle Size (µm)	Application Thickness	Notes	FDA
TL-581	ETFE	260	18 - 25	250 - 300	2 - 5 mm		✓
LM-2300	LM-ETFE	225	15 - 20	300 - 500	2 - 5 mm	Glossier finish	✓
EA-2000 PW50	PFA	298	10 - 14	20 - 50	1 - 3 mm	Enhanced adhesion	×

Rotolining Process



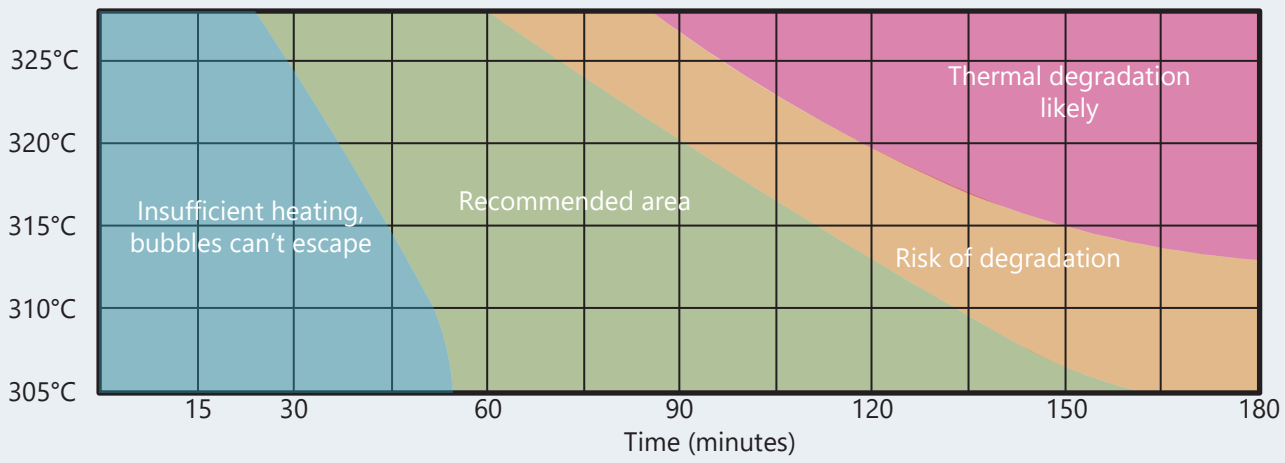
[Left] Rotation around a single axis is less complex, and ideal for lining simple constructions such as pipes. A uniform coating thickness is easy to achieve on simpler parts.

[Right] Using multiple axes for rotation allows for the lining of more complex parts such as pumps and manifolds. Depending on the complexity of the parts being coated, the rotation speed of the axes can be altered independently to achieve uniform thickness while avoiding molten polymer pooling in channels.

Heating Guidelines

It is important to consider the overall thermal exposure for ETFE during rotolining. This includes the preheating, coating and cooling cycles. Insufficient heating will result in an inferior coating, with gas bubbles trapped within the coating, that could lead to pathways that enable corrosion during service. Excessive heating can lead to degradation of the polymer, resulting in breakdown of the coating layer either before or during the early stages of service, giving poor product life.

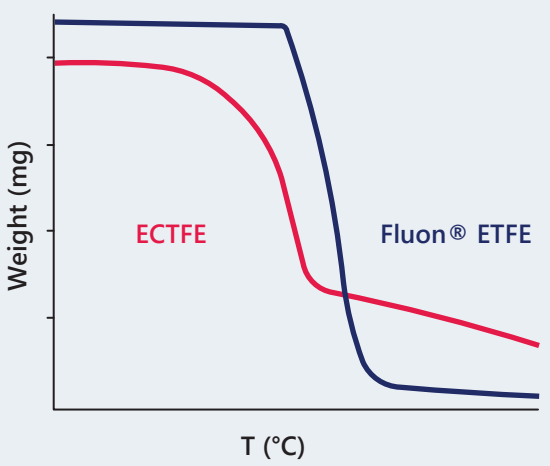
The following chart can be used as a guide for optimising the process window.



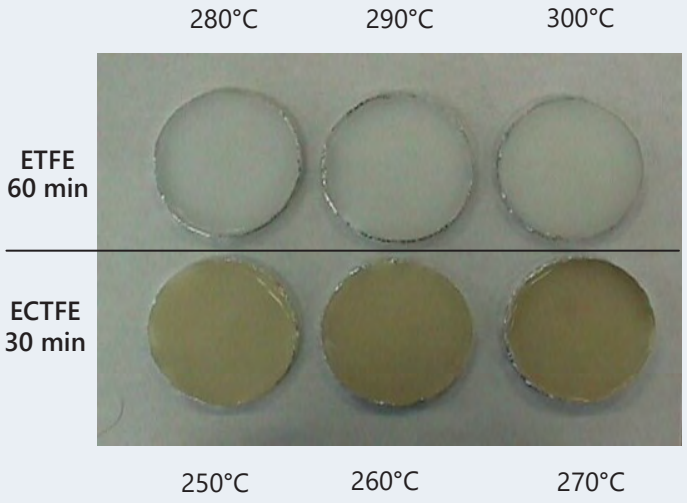
Thermal Stability

While chemically similar, ECTFE and ETFE show some differences when it comes to their resistance to elevated temperatures. TGA analysis also shows that Fluon® ETFE degrades at a higher temperature than ECTFE. This is because the C-Cl bond (327 $kJ.mol^{-1}$) present in ECTFE is weaker than the C-F bond (485 $kJ.mol^{-1}$), and ECTFE will therefore begin to break down at lower temperatures than ETFE.

Thermal degradation will often show as discolouration initially, as shown in the photograph below.



Thermogravimetric analysis shows initial mass loss of Fluon® ETFE at considerably higher temperature when compared to ECTFE.



Visual comparison of the effects of thermal ageing on Fluon® ETFE versus ECTFE. Yellow discolouration indicates a greater degree of thermal degradation.

Chemical Resistance Guide

Chemical	%	Temperature (°C)					
		25	50	75	100	110	120
Sulfuric Acid	25						
	50						
	80						
	95						
Hydrochloric Acid	5						
	35						
Nitric Acid	5						
	60						
Phosphoric Acid	20						
	85						
Hydrofluoric Acid	10						
	50						
Hydrobromic Acid	40						
Acetic Acid	10						
	96						
Oxalic Acid	20						
Citric Acid	40						
Potassium Hydroxide	25						
Sodium Hydroxide	10						
	25						
	48						
Ammonium Hydroxide	10						
	25						

Chemical	%	Temperature (°C)					
		25	50	75	100	110	120
Ethanol	100						
Methanol	100						
Ethylether	100						
Butylether	100						
Acetone	100						
MEK	100						
Ethyl Acetate	100						
Methylene Chloride	100						
Chloroform	100						
Carbon Tetrachloride	100						
Sodium Hypochlorite	6						
Chlorine Dioxide	15						
Hydrogen Peroxide	35						
Chlorine (Dry)							
Chlorine (Wet)							
Bromine							
Acetaldehyde	100						
Toluene	100						
Hexane	100						
Phenol	100						
Gasoline	100						
Kerosene	100						
Naphtha	100						

Sample: Steel plate with Fluon® ETFE lining of 0.6~0.8mm thickness

not affected

slight effect detected - but possible to use

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