High-Performance Plastics Machining & Tolerance Guide

Manufacturing Capabilities and Precision Standards for PTFE, PFA, PEEK, PPS, PVDF, and PI

Introduction

This guide provides detailed information about manufacturing capabilities for high-performance engineering plastics, including available processing methods, achievable tolerances, and standard practices. Understanding these capabilities helps customers optimize their designs for manufacturability while achieving required performance specifications.

1. Processing Methods by Material Type

PTFE (Polytetrafluoroethylene) Processing

Characteristics: Cannot be melt processed due to high melting point and low melt viscosity. Requires specialized forming techniques.

- Compression Molding: Powdered resin compressed in mold and sintered at 360-380°C
- Paste Extrusion: Paste of fine powder and lubricant extruded then sintered
- Skiving: Cutting thin sheets from sintered billets
- Machining: CNC turning and milling of sintered stock

PFA (Perfluoroalkoxy) Processing

Characteristics: Melt-processable fluoropolymer with excellent flow properties. Can be processed using conventional thermoplastic techniques.

- Injection Molding: Standard thermoplastic injection molding equipment
- Extrusion: Single or twin-screw extrusion for tubes and profiles
- Blow Molding: For hollow containers and vessels
- Machining: CNC turning and milling of extruded or molded stock

PEEK (Polyether Ether Ketone) Processing

Characteristics: High-performance thermoplastic with excellent processability. Requires high processing temperatures but compatible with standard equipment.

- Injection Molding: Processing temperatures 360-400°C, high barrel pressures
- Extrusion: Single or twin-screw extrusion for profiles and sheets
- Compression Molding: For large or thick cross-section parts
- Machining: CNC turning and milling, sharp tools required due to abrasiveness

2. Dimensional Tolerances by Material

Standard Dimensional Tolerances

Nominal Dimension Range	PTFE (±mm)	PFA (±mm)	PEEK (±mm)	PPS (±mm)	PVDF (±mm)	PI (±mm)
Up to 10mm	0.10	0.05	0.03	0.04	0.05	0.04
10-50mm	0.15	0.08	0.05	0.06	0.08	0.06
50-100mm	0.20	0.10	0.08	0.10	0.10	0.08
100-200mm	0.30	0.15	0.12	0.15	0.15	0.12
Over 200mm	0.50	0.25	0.20	0.25	0.25	0.20

Geometric Tolerances

Characteristic	Standard Tolerance	Applicable Materials	Notes
Flatness	0.1mm per 100mm	All materials	For sealing surfaces
Roundness	0.05mm	All materials	Shaft diameters
Straightness	0.1mm per 100mm	All materials	Long components
Parallelism	0.05mm per 25mm	All materials	Flange faces
Perpendicularity	0.1°	All materials	Mounting surfaces
Concentricity	0.1mm	All materials	Rotating parts

Surface Finish Requirements

Finish Type	Ra Value (μm)	Applicable Materials	Applications
Standard Machined	3.2-6.3	All materials	General components
Fine Turned	1.6-3.2	PEEK, PPS, PVDF	Sealing surfaces
Polished	0.8-1.6	PTFE, PFA, PI	Optical or clean room
Mirror Finish	0.2-0.8	PI, PEEK	Precision instruments

3. Manufacturing Equipment Capabilities

CNC Turning Centers

Specification	Capacity	Accuracy
Max. Swing Diameter	400mm	±0.02mm
Max. Workpiece Length	1000mm	±0.05mm
Spindle Speed Range	50-2000 RPM	Variable control
Positioning Resolution	-	±0.005mm
Tool Holders	ER16, ER20, ER25	Multiple options

CNC Milling Centers

Specification	Capacity	Accuracy
Work Envelope (X×Y×Z)	500×400×300mm	±0.03mm
Max. Spindle Speed	12000 RPM	Precise control

Tool Magazine Capacity	20 positions	Automatic change
Minimum Corner Radius	0.5mm	Depends on tooling
Surface Finish Capability	Ra 1.6μm	Standard option

4. Material-Specific Manufacturing Considerations

PTFE Specific Considerations

- Cold flow behavior requires design modifications for load-bearing applications
- Sintering cycle time affects crystallinity and final properties
- Machining produces directional properties due to fibrillation
- Post-machining stress relief recommended for critical dimensions

PEEK Specific Considerations

- Moisture absorption affects dimensional stability - drying before processing
- High melt viscosity requires specialized screw designs
- Crystallization rate affects part properties - controlled cooling required
- Abrasive nature causes tool wear - carbide or PCD tools recommended

5. Quality Assurance & Inspection

All high-performance plastic components are manufactured under strict quality control procedures. Each order undergoes multiple inspection stages:

- Raw material certification verification
- In-process dimensional checks
- Final inspection with calibrated measuring equipment
- Documentation package preparation

Available Inspection Equipment

Equipment Type	Measurement Range	Accuracy
Digital Calipers	0-300mm	±0.02mm
Outside Micrometers	0-100mm	±0.002mm
Height Gauges	0-600mm	±0.03mm
Coordinate Measuring Machine (CMM)	500×400×300mm	±0.005mm
Surface Roughness Tester	0.02-10μm Ra	±0.01μm
Profile Projectors	Up to 200mm	±0.01mm

Conclusion

This machining and tolerance guide represents our current capabilities for high-performance plastic component manufacturing. For applications requiring tighter tolerances or special processing techniques, we recommend consulting with our engineering team to discuss custom solutions.