Introduction to Fluon+™ Filled PTFE Compounds

AGC Chemicals Americas, Inc.

Fluon+™ Enhanced Material Science

Your Dreams, Our Challenge

Smart Chemistry Solutions

- U.S. headquarters & manufacturing near Philadelphia
- Certified ISO 9001:2015 and 14001:2015
- Custom compounds and formulations for high-quality fluorochemicals and specialty chemicals
- Short production lead times, system-controlled specifications, product consistency
- Onsite physical, analytical and wear testing
- Compression and injection molding equipment to optimize product

Why Fluoropolymer Compounds?

- Fluoropolymer resins impart unique characteristics.
- Performance is further increased by the use of various fillers.
- AGC offers filled PTFE compounds and melt processable compounds.

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Introduction to Filled PTFE Compounds

Low Flow - non-pelletized

Free Flow - pelletized

Fluon+ FPC™
Filled PTFE Compounds

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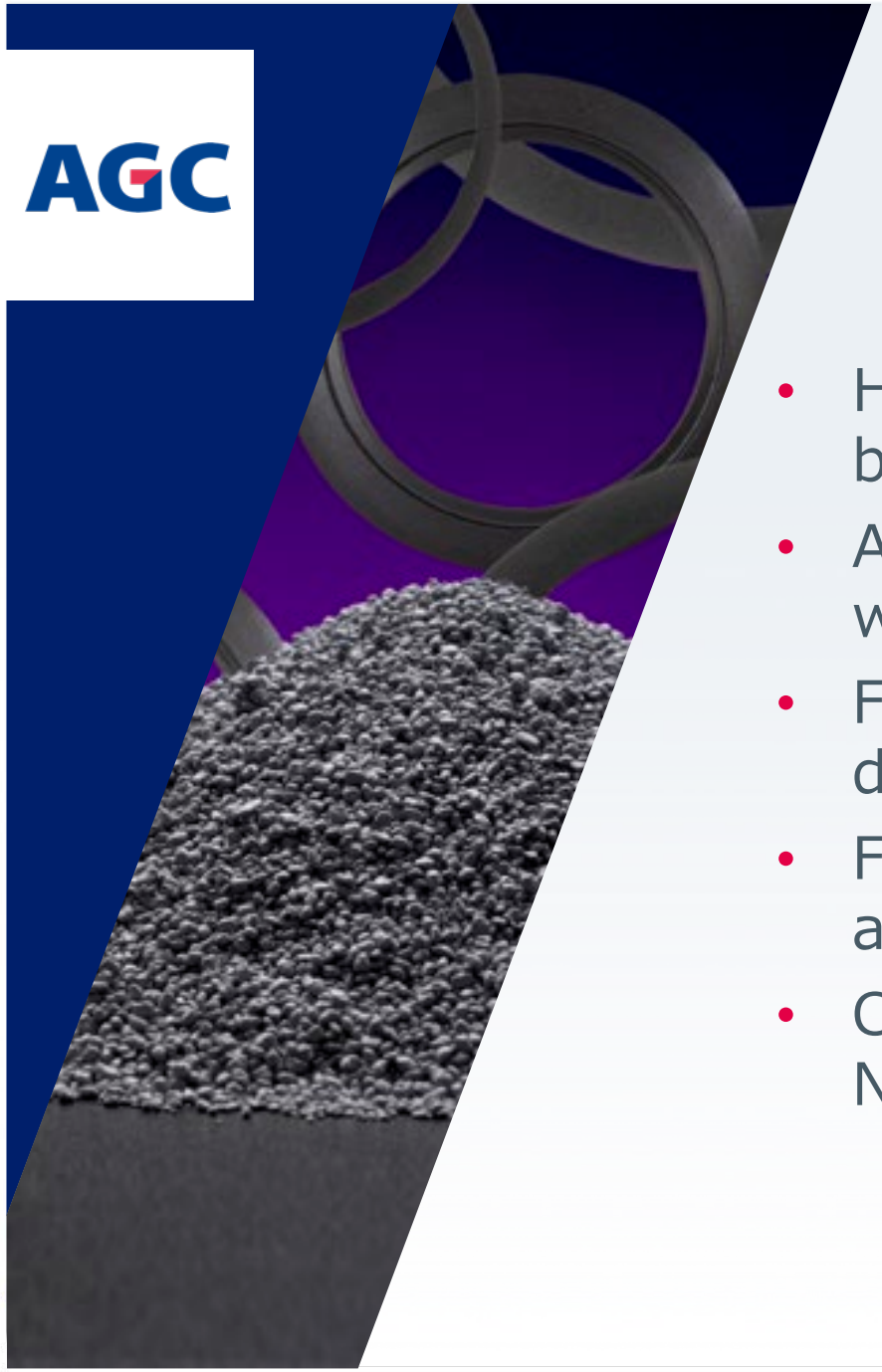


Filled PTFE Compounds

- High shear modulus fillers are encapsulated and bound by the low shear modulus PTFE resin.
- Addition of fillers can minimize deficiencies of PTFE while preserving many of its desirable properties.
- Fillers must be compatible with PTFE; they cannot dramatically diminish its desirable properties.
- Fillers are used to control unwanted creep, as well as improve wear, friction, and tensile properties.
- Choice of filler is strongly application-dependent. No one filler addresses all deficiencies.

Two Forms of Filled PTFE Compounds

Low Flow

- Produced by dry-blending neat resin with filler
- End product resembles cake flour
- Used for simple compression molding such as bars and large billets

Free Flow

- Low flow blend used as feed for free flow
- Compound is wetted, pelletized, and dried
- End product is small pellets
- Physical properties of free flow compounds are generally decreased compared to low flow compounds
- Use for automatic compression and isostatic molding, such as sleeves

PTFE Filler Requirements

- Thermal stability of at least 750 °F to withstand PTFE processing temperatures
- Chemical resistance
- Particle size and distribution must be consistent with PTFE base
- Ability to interrupt PTFE transfer during wear:
  - Modulus greater than PTFE
  - Reasonable lubricity
  - Non-abrasive
- Deformation resistance

Potential Impact of Fillers

Increase	Generally Decrease
Wear Resistance	Chemical Resistance
Deformation Resistance	Dielectric Strength
Tensile Properties	
Thermal Conductivity	
Thermal Expansion	
Friction	
Compressive Strength	
Electrical Conductivity	

Filled PTFE Compounds: Fillers

- **Fibrous**
  - Glass
  - Carbon/Coke
  - Mineral
- **Blends**
  - Glass/MoS_2
  - Bronze/MoS_2
- **Other fillers and blends available upon request**

- **Non-fibrous**
  - Glass
  - Carbon/Coke
  - Mineral
  - Molybdenum Disulfide (MoS_2)
  - Bronze
  - Stainless Steel
  - Polyphenylene Sulfide (PPS)
  - Polyimide (PI)
  - Linear aromatic polyester (LAP)

Filled PTFE Compounds: Markets Served

- **Ground Transportation**
  - Automotive & Rail
  - Heavy-duty Equipment
- **Energy**
  - Exploration
  - Production
  - Refining
  - Renewable
- **Aerospace**
  - Commercial
  - Defense
- **Industrial**
  - Fluid control
  - Industrial Equipment
  - Pulp & Paper
  - Food & Beverage
  - HVAC

Filled PTFE Compounds: Applications

- Bearings
- Gaskets
- V-rings
- Chevron packings
- O-rings
- Back-up rings
- Hydraulic ring seals
- Non-lubricated compressor rings
- Self-lubricating bearings
- Valve seats
- Valve liners
- Swivel liners
- Thrust washers
- Lip seals
- Standoff and feed-through insulators
- Wear pads

Glass-Filled PTFE Compounds: Features and Applications

Glass-Filled Features

- Improve wear characteristics
- Improve compression strength
- Reduce creep relaxation
- Improve abrasion resistance by blending with graphite and/or MoS_2

Glass-Filled Applications

- Hydraulic piston rings
- Gaskets
- Self-lubricating bearings
- Valve seats
- Big-billet skived sheet

MoS_2-Filled PTFE Compounds: Features and Applications

MoS_2-Filled Features

- Increase hardness and stiffness
- Improve wear resistance
- Greatly reduce torque on start-up
- Lower coefficient of friction
- Good for dry, greaseless applications

MoS_2-Filled Applications

- Self-lubricating bearings
- Seals and gaskets
- Compressor rings
- V-rings, O-rings and backup rings
- Valve seats and liners

Graphite-Filled PTFE Compounds: Features and Applications

Graphite-Filled Features

- Excellent lubricity due to flaky structure
- Decrease wear, especially to soft metals
- Good wear resistance in wet environments
- Typically combined with carbon or glass to lower the coefficient of friction

Graphite-Filled Applications

- Static-dissipating gaskets
- Compressor rings
- Valve seats and liners
- Piston rings and seals

Carbon-Filled PTFE Compounds: Features and Applications

Carbon-Filled Features

- Excellent compression strength (deformation under load)
- Excellent wear resistance
- Less abrasive than glass, but more abrasive than polymer-filled compounds
- Good thermal conductivity and low permeability
- Often combined with graphite for enhanced wear and friction properties

Carbon-Filled Applications

- Static-dissipating gaskets
- Compressor rings
- Valve seats and liners
- Piston rings and seals

Mineral-Filled PTFE Compounds: Features and Applications

Mineral-Filled Features

- Good wear resistance
- Increased creep resistance
- Good compressive strength
- Excellent chemical resistance
- Less abrasive than glass
- FDA food and 3A sanitary compliant

Mineral-Filled Applications

- Seals
- Compressor rings
- Valve seats and liners
- Food and beverage applications

Bronze-Filled PTFE Compounds: Features and Applications

Bronze-Filled Features

- Excellent wear resistance
- Excellent thermal conductivity
- Improved creep resistance and deformation under load
- Less chemically resistant than other filled PTFE compounds
- Sometimes combined with MoS_2 to lower coefficient of friction

Bronze-Filled Applications

- Self-lubricating bearings
- Gaskets – static-dissipating/others
- Seals
- Compressor rings
- Valve seats/liners

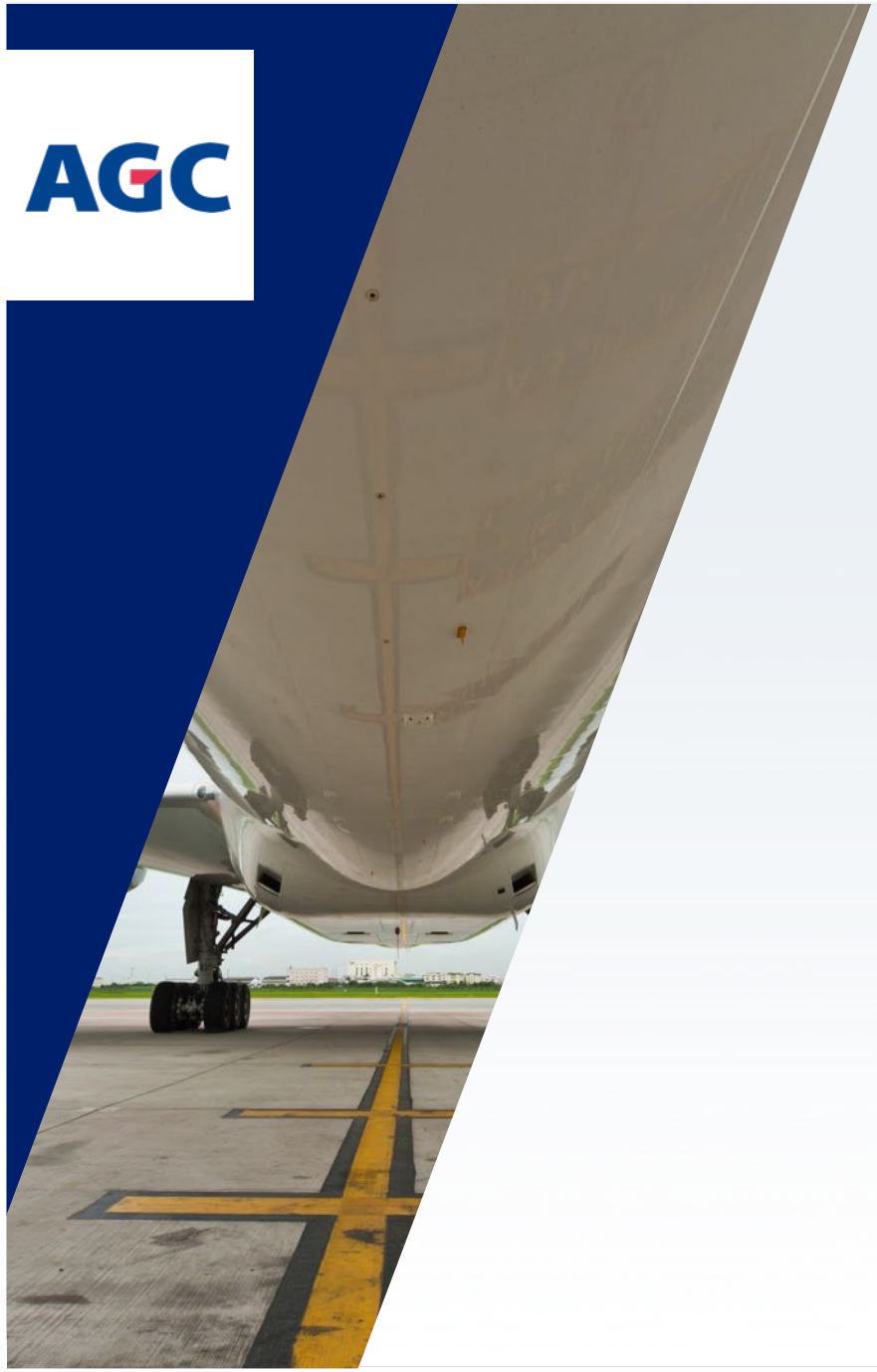
Stainless Steel-Filled PTFE Compounds: Features and Applications

Stainless Steel-Filled Features

- High wear resistance
- High load-bearing capability
- Improved chemical resistance over bronze-filled PTFE compounds
- Typically used in steam service

Stainless Steel-Filled Applications

- Gaskets
- Seals
- Ball valve seats



PPS-Filled PTFE Compounds: Features and Applications

PPS-Filled Features

- Excellent dimensional stability
- Excellent thermal stability
- Improved wear and abrasion properties
- Excellent deformation and extrusion resistance

PPS-Filled Applications

- Seals
- Compressor rings
- Backup rings
- Hydraulic aircraft seals

Polyimide-Filled PTFE Compounds: Features and Applications

Polyimide-Filled Features

- Improved wear and abrasion properties
  - Ideal for soft surfaces
- Lowest friction properties of all filled PTFE compounds
  - Provides great performance in non-lubricated applications
- Improved deformation and extrusion resistance

Polyimide-Filled Applications

- Seals
- Compressor rings
- Self-lubricating bearings
- Piston rings

Linear Aromatic Polyester (LAP)-Filled PTFE Compounds: Features and Applications

LAP-Filled Features

- Excellent dimensional and thermal stability
- Improved wear and abrasion resistance
  - Good for metal mating surfaces
- Applicable for rotary applications

LAP-Filled Applications

- Seals
- Compressor rings
- Self-lubricating bearings

Contact Us for More Information

Fluon+™

Enhanced Material Science

Learn more

www.agcchem.com

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