



*Precious like Gold*

*TECAPOWDER PI*

# Polyimide Powder

TECAPOWDER PI polyimides, the top end of high-performance plastics, are useful in various demanding applications in industries such as aerospace, semiconductor, automotive, aircraft, plasma-welding and diamond wheel. No other plastic material keeps more superlatives in its designation than polyimides. TECAPOWDER PI is based on P84® by Evonik. BTDA and PMDA monomers reacted with isocyanates to produce fully imidized polyimide resins without the need for post curing.

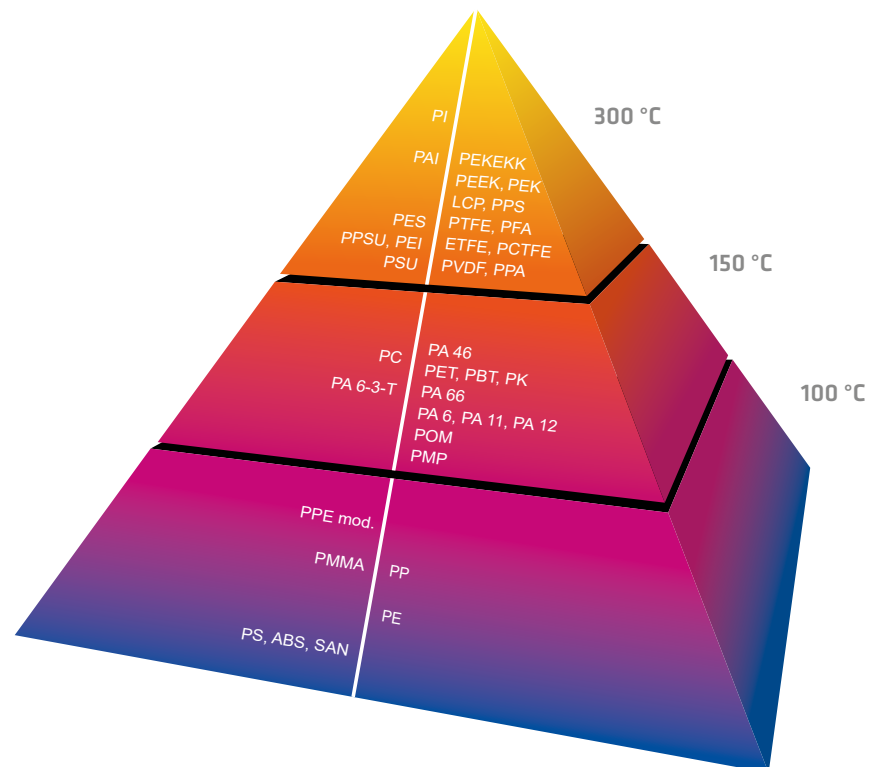
Since 1984 the production and the development of TECAPOWDER Polyimide Powder has been situated in Austria, Lenzing. The Ensinger group is engaged in the development, manufacture and sale components made of engineering and high-performance plastics. Further development of proven production techniques, new applications and international expansion have earned the enterprise a place among the leaders in its field.

## Material Properties of TECAPOWDER PI

TECAPOWDER PI offers outstanding properties, such as high temperature stability, excellent chemical resistance, high mechanical strength, a low friction coefficient and minimal abrasion. The material can be used in applications where conventional plastics melt or soften or when thermal degradation occurs quickly.

## Advantages

- Broad range of temperature from -270 up to +300 °C (-500 up to +570 °F)
- In long term service high stability and high creep resistance
- Low outgassing, high purity
- Outstanding radiation resistance
- Electrically insulating
- Excellent slide and wear properties
- Strain resistant
- Good chemical resistance



# TECAPOWDER PI Product Line

## **TECAPOWDER PI STD yellow (Standard)**

- 40 mesh
- 200 mesh
- 325 mesh
- 425 mesh
- 1200 mesh

TECAPOWDER PI STD (standard) grades are used for polymer alloys, plasma spray coatings, direct forming and composites. STD grades have no heat history and are fully reactive and sinterable.

## **TECAPOWDER PI SG yellow (Solution Grade)**

- Granulates
- 200 mesh

## **TECAPOWDER PI SG HT yellow**

- Granulates

TECAPOWDER PI solution grade materials are used in wire coatings and adhesives. SG grades are for solution blending in dissolving in DMF, DMSO or other polar solvents.

## **TECAPOWDER PI VPD and HT VPD yellow (Vacuum Predried and Vacuum Predried – High Temperature)**

- 1200 mesh

## **TECAPOWDER PI HT yellow**

- 325 mesh
- 325/1200 mesh
- 425 mesh
- 1200 mesh

TECAPOWDER PI HT VPD grades are highly crosslinked which allows their use as a filler in many fluoropolymers. Small mesh sizes enable good properties and uniform colour in sintered PTFE compounds.

## **TECAPOWDER PI HCM yellow (Hot Compression Moulding)**

- 40 mesh
- 200 mesh
- 325 mesh
- 425 mesh
- 1200 mesh

TECAPOWDER PI HCM grades are used to mould high-performance stock shapes. Virgin grades use 40 mesh and our blended grade is 325 mesh.

## **TECAPOWDER PI HCM Blends**

- TECAPOWDER PI HCM GR15 black
- TECAPOWDER PI HCM GR40 black
- TECAPOWDER PI HCM TF30 yellow
- TECAPOWDER PI HCM CF10 TF5 GR5 black
- TECAPOWDER PI HCM GF30 yellow
- TECAPOWDER PI HCM CF20 black
- TECAPOWDER PI HCM CF30 black40G

TECAPOWDER PI HCM blends contain various fillers for high-performance semifinished products based on the end use requirements. Graphite grades are for excellent bearing and wear resistance parts.

## **TECAPOWDER PI HCM HT yellow and blends (Hot Compression Moulding – High Temperature)**

- 40 mesh
- 325 mesh
- 1200 mesh

## **TECAPOWDER PI HCM HT Blends**

- TECAPOWDER PI HCM HT GR15 black
- TECAPOWDER PI HCM HT GR40 black
- TECAPOWDER PI HCM HT TF30 yellow
- TECAPOWDER PI HCM HT CF20 yellow

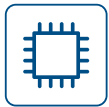
TECAPOWDER PI HCM HT yellow and blends are used for high-performance stock. Heat history on the powder enables compression moulding without outgassing and cracks in final stock shapes.

# TECAPOWDER PI – Product Line

TECAPOWDER PI resins are produced in various particle size distributions, fillers and grades based on the intended end use and process method.

- HCM (hot compression moulding) grades are available unreinforced or with fillers such as graphite powder for compression moulding or ram-extrusion into stock shapes or direct formed into finished parts.
- VPD (vacuum pre-dried) grades are used as low level fillers in PTFE materials. 5-20% loadings of TECAPOWDER PI VPD in PTFE create wear resistance PTFE compounds that extend the performance envelope of standard PTFE materials especially at high pressures, velocities, and temperatures. P84 Polyimide filled PTFE compounds are good running against soft mating surfaces. Standard PTFE free sintering process conditions are used to mould these compounds.

## Industries



Semiconductor  
& Electronics  
Manufacturing



Mechanical



Aerospace



Renewable  
Energy



Glass



Mobility



Oil & Gas



Winter  
Technology

## PI Moulding Powder for High-Performance Parts

TECAPOWDER PI HCM grades are used to make high-performance polyimide stock shapes and finished parts. They are heat aged in vacuum so that high quality stock shapes can be moulded without the need for post curing. Large billets can be moulded without cracking. HCM grades are available unreinforced, or with fillers such as graphite powder for compression moulding, or ram-extrusion into stock shapes or direct formed into finished parts.

## Outstanding Properties

Excellent thermal resistance makes TECAPOWDER PI HCM parts useful in many markets. Depending on the fillers, the outstanding properties can be customised to suit the application.

## TECAPOWDER PI for Speciality Markets

TECAPOWDER PI HCM grades are available in virgin grades and blended grades, custom formulations can be readily made. TECAPOWDER PI HCM blends contain various fillers based on the end use application. Graphite filled grades are excellent for bearings or bushings that require high wear resistance, often without lubrication. Glass filled TECAPOWDER PI HCM is useful in the metal spinning industry. Rollers made with glass fiber filled TECAPOWDER PI HCM produce a smooth finish on metal parts.

All TECAPOWDER PI compounds are widely available and custom formulations can be readily made.

# PTFE Compounds

The reinforcement of PTFE with high-performance polymers has many advantages compared to inorganic fillers. The most important properties are the excellent wear behavior without abrasion of the sliding partner. TECAPOWDER PI is an active filler in PTFE. This is shown by a highly increased creep resistance and a good mechanical bonding of the powder into the matrix.

The development of extremely fine powders lead to excellent surfaces of machined parts and skived films of these compounds.

## PTFE Compounds Replace Other Materials

TECAPOWDER PI filled PTFE compounds outperform inorganic fillers in many ways. Many inorganic fillers have poor wear resistance, low elongations at high loadings and some fillers can be abrasive to the mating surface.

<i>Application</i>	<i>Replacement (type of compounds)</i>	<i>Replaced material</i>
Compressor parts piston and rider rings in bone dry applications	85/15 and 80/20	PEEK composites, PTFE/bronze and PTFE/carbon/graphite compounds
Hydraulic seals, spring reinforced and others	93/7 and 90/10	PTFE/carbon, PTFE/bronze and PTFE/EKONOL
Dynamic seals in air components	80/20 and 85/15 P1	PE/carbon compounds, rubber and PUR seals
Sealing bands for turbo charger	80/20	PTFE/bronze
Sealing bans for shock absorbers	75/20/5	PTFE/bronze/MoS <sub>2</sub> compounds Most other PTFE compounds
Sliding liner for multilayer bearings in automotive applications	75/25 and 75/20/5, standard and paste types	PTFE/MoS <sub>2</sub> and PTFE/lead compounds
Inner liner for push-pull cables	Proprietary paste, compounds	PTFE/glass types, PTFE/PPS compounds
Guidance films for pistons and gliding components, esp. in weaving equipment	85/15 with 1200 mesh, also with NPA additive	RULON

# TECAPOWDER PI

## Compositions Tailormade for Different Applications

Lip-seals, packings, and spring-reinforced dynamic seals	93% PTFE / 7% PI
Rod packings, rider and piston rings in compressor applications, proved in "bone-dry" gas compressors as a piston and rider ring, skived films as gliding surfaces on several machinery elements, especially in textile equipment	85% PTFE/15% PI
Bearings and gliding elements in highly stressed applications. Sealing bands for rotating equipment in compressors and pumps	80% PTFE/20% PI
Piston rings in pumps and compressors for dry gases, gliding elements in weaving machines	75% PTFE/20% PI/5% Graphite
This composition for hot moulding is used in high-load bearings and sealants in machining equipment and as guidance material in mechanical end uses	60% PTFE/40% PI
Push-pull cable inner-liners to maintain long service life without any additional lubrication	90% PTFE/10-15% PI

### PI in PTFE Compounds Improves the Properties

The most important properties of TECAPOWDER PI filled PTFE are excellent wear resistance at elevated temperatures, high elongation, and no abrasion of the sliding partner – all without the need for lubrication.

TECAPOWDER PI as an active filler in PTFE improves the mechanical properties of the PTFE. Blending 5-20% loadings of TECAPOWDER PI VPD in PTFE creates wear resistant PTFE compounds that extend the performance envelope of standard PTFE materials especially at high pressures, velocities and temperatures. TECAPOWDER PI filled PTFE compounds are especially good running against soft mating surfaces.

- Good chemical resistance
- Very good slide & wear properties
- High toughness
- Lower friction and wear
- High electrical insulation

### TECAPOWDER PI Solutions Have Many advantages for Coatings

TECAPOWDER PI solution grade granulate has important uses in the industry due to the unique combination of high temperature stability and chemical resistance.

Specialty coatings made of TECAPOWDER PI granulate allow customers to formulate different weight percent solids content and allow for various additives to improve end use characteristics. The fully imidized solutions can be used as structural adhesives and bond very well to most metals.

### PI as a Binding Resin for Diamond and CBN Grinding Wheels

TECAPOWDER PI is a non-meltable polymer that improves the performance of grinding wheels in demanding applications. It is based on P84<sup>®</sup> by Evonik. The binding materials require a high strength at elevated temperatures. These requirements are met by polyimides due to their chemical structure.

### **Outstanding Properties**

The physical properties of TECAPOWDER PI meet the requirements, which are demanded from grinding wheels. TECAPOWDER PI has a high glass transition temperature of 330-340 °C (626-644 °F) based on the moulding parameters used to sinter the resin.

- High load bearing capacity  
Due to its excellent thermal stability, TECAPOWDER PI bonded wheels have extremely high load-bearing capacity. They are particularly well suited for applications involving hard metal (dry) grinding and deep grinding (wet) operations.
- Influencing the properties by changes of the processing  
The hardness, brittleness and abrasion capacity of TECAPOWDER PI wheels can be influenced by processing. Varying the sintering temperature and dwell time can lead to different mechanical properties of the resin. As the process temperature and dwell times rise, the grinding area becomes harder and more brittle. This temperature moulding window is between 330 °C and 360 °C (626 and 680 °F).

### **Polyimides in Polymer Blends**

Reinforcing with PTFE and/or graphite is used to improve wear properties of thermoplastics in tribological applications. Now it is possible to improve the wear resistance in other polymers with the use of TECAPOWDER PI. The addition of PI increases the tribological properties as well as the thermal resistance. Blending work has been done with PES, PPS, EPOXY, PUR and PAEK. The reinforcement levels require only a very small amount of PI to obtain the improved properties. In some cases sufficient results were reached under the use of only 2 to 5 % polyimide in the base resin. It has been found that in combination with other polymers, the mechanical properties also will be increased. One example is PPS. The reduction of softening at temperatures near the Tg of such high-performance polymers helps in many applications. Possible applications:

- Sliding parts in mechanical equipment, compressor seals, piston rings and valve plates
- Lubricant free bearings and dynamic seals on different applications

### **Applications for the Semiconductor Industry**

TECAPOWDER PI is a high purity polyimide specifically developed to meet the demanding needs of the chip manufacturing industry. It is a unique polyimide that can be fabricated into machined parts without the need for a secondary, post-curing step. The finished parts exhibit uniform imidization from the outer skin to the inner layers. The fully imidized material shows extremely good chemical resistance to various acids and plasma gases used in the processing of silicon wafers into integrated chips.

### **Outstanding Properties**

- High purity
- Non meltable
- Dimensionally stable at elevated temperatures
- Machinable into finished parts
- Excellent plasma resistance

### **Thermal Stability**

TECAPOWDER PI can be used in critical etching processes where chamber temperatures are high. The long term thermal stability of this material is excellent. Its flex strength of high especially at elevated temperatures. A high percentage of its room temperature flexural strength is maintained even at elevated temperatures. Since the glass transition temperature is very high, the dimensional stability up to its Tg is very good. TECAPOWDER PI is a non-meltable polymer, therefore, it has excellent creep under load at high exposure temperatures.

### **Chemical Resistance**

The fully imidized nature of TECAPOWDER yields excellent chemical resistance to various solvents, acids, and hydraulic fluids. TECAPOWDER is produced using novel isocyanate technology which yields a unique, fully imidized material without the need for curing. Other polyimides must be moulded and cured. The curing closes the imide rings and produces water as a by-product that migrates out through the surface. Fabricated parts made from TECAPOWDER PI are non-porous, which minimises the migration of fluids into the surface layers and greatly improves chemical resistance.

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