

A Polymer Powerhouse:

Unveiling the Stellar Advantages of Polyketone for Additive Manufacturing of ESD-Safe Components



Introduction

In the realm of Additive Manufacturing (AM), a variety of materials are accessible for the creation of durable and functional parts. One such material, Polyketone (PK), has emerged as a promising alternative to Polyamide (PA) due to its unique set of advantages.

PK ESD, a material of particularly high promise in the field of AM, offers exceptional benefits when compared to the commonly used PA ESD options. Through meticulous engineering, PK ESD possesses properties that render it an outstanding choice for industries where the control of electrostatic discharge is of utmost importance. Notably, PK ESD exhibits exceptional dimensional stability and excellent resistance to chemicals, thereby ensuring remarkable durability and reliability even in demanding environments. Additionally, its low moisture absorption and high heat resistance make it well-suited for a wide range of applications.

The versatility and superior performance of PK ESD make it stand out in the field of AM, paving the way for countless new possibilities across diverse industries. With its exceptional qualities and unparalleled capabilities, PK ESD emerges as a dependable solution to meet the demands of various sectors.

In this article, we will explore the benefits of using PK ESD over PA ESD for AM, highlighting its eco-friendly nature, exceptional mechanical properties, and superior chemical resistance.

Discover the advantages of using Polyketone over Polyamide for Additive Manufacturing of ESD-safe components. Learn how this eco-friendly material offers superior mechanical properties and chemical resistance.



PK ESD Delivers Cost Benefits

Mechnano's PK ESD is priced at a competitive rate of \$140/kg, offering substantial savings when compared to the average price of polyamide-based static dissipative powders in the market, which stands at around \$205/kg. When PK ESD and Laser Sintering technologies are employed for part manufacturing, the production cost for a 3×4-inch PCB enclosure (see **Figure 1**), for instance, reduces the unit cost to approximately **\$2**. This cost stands in stark contrast to the traditional method of fabrication, where an enclosure of the same size typically amounts to around **\$150** per part. Additionally, the use of PK ESD brings financial benefits to end-users by extending the lifespan of tools and equipment, hence minimizing the frequency of replacements and maintenance. Through the elimination of electrostatic discharge-related damages, companies can significantly save on expenses related to replacement costs, downtime, and labor associated with frequent repairs.



Figure 1: Photograph of PCB cases fabricated using PK ESD.

The Time-Saving Advantages of Laser Sintering Technology

The employment of Laser Sintering in part manufacturing using PK ESD presents a considerable decrease in lead time when compared to the traditional mold tooling with carbon fiber or carbon black composites. Certain static dissipative components, which typically require a lead time of 3 months, can now be manufactured in quantities exceeding **100** units in just one build job within a span of **24** hours. Furthermore, the implementation of Mechnano's PK ESD material has demonstrated tangible time benefits by reducing the



downtime associated with equipment failures caused by electrostatic discharge. Actual timeframes show a decrease in production interruptions and maintenance needs, resulting in improved operational efficiency and increased productivity.



Outstanding Mechanical Performance

PK ESD Powder is specifically designed to provide superior material properties that effectively dissipate electrostatic charges, safeguarding delicate electronic components from potential damage. In comparison to commonly used polyamides in Laser Sintering processes, PK ESD stands out with its exceptional impact strength, IZOD notched measuring at an impressive 90 J/m (10-80% higher than ESD Polyamides). It has a heat deflection temperature 20-70°C higher compared to ESD Polyamides, ensuring enhanced heat resistance. PK ESD also demonstrates exceptional elongation at break, surpassing 30%, while delivering comparable tensile and flexural performance (see Figure 2).

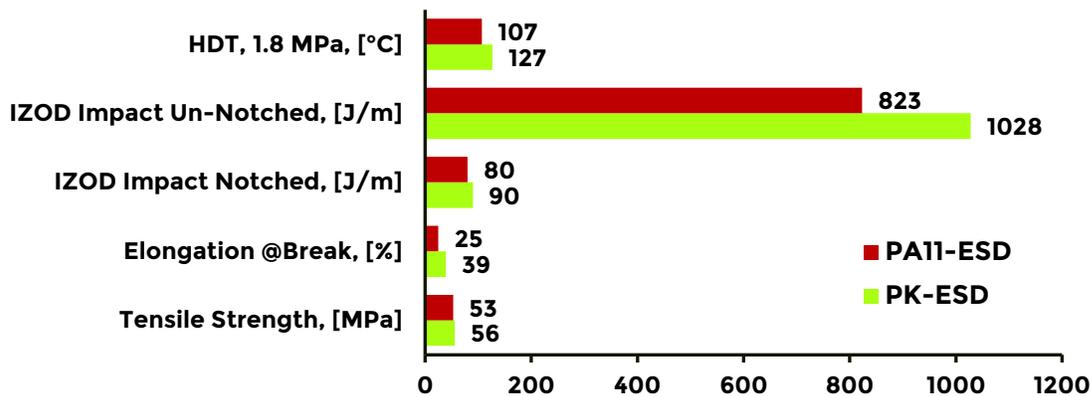


Figure 2: Performance comparison of PK ESD versus PA-11 Laser Sintering materials.

Additionally, it retains the inherent advantages of the base Polyketone, such as excellent chemical resistance, improved wear, and friction properties. This ensures optimal durability and longevity in various applications. What sets PK ESD apart is its low toxicity and minimal carbon footprint, making it an environmentally conscious choice that fulfills the requirements of diverse end-users.

Unparalleled Chemical & Water Resistance

Another notable advantage of PK ESD is its superior chemical resistance compared to Polyamide. PK is unique among engineering plastics due to its all-carbon backbone, providing superior chemical resistance in comparison to other engineering plastics that incorporate oxygen and nitrogen atoms in their backbone structures (see Figure 3).

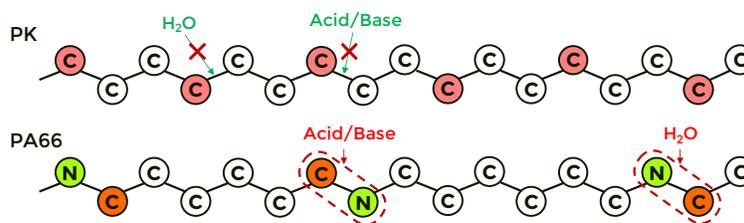


Figure 3: All-carbon backbone of PK provides superior chemical resistance compared to PA.



PK exhibits excellent resistance to a wide range of chemicals, including solvents, acids, and alkalis (see **Table 1**). This makes it highly suitable for applications where exposure to harsh chemicals is common, such as chemical processing plants or medical devices.

Polyamide, on the other hand, may be susceptible to chemical degradation over time, limiting its usefulness in certain environments. By choosing PK for additive manufacturing, manufacturers can ensure that their products remain intact and functional even when exposed to corrosive substances.

Moisture content and humidity levels can impact the performance of materials over time. As a result, specialty Polyamides such as PA12 and PA612, which have longer and more hygroscopic carbon chains in their structure, are commonly chosen for applications where maintaining consistent properties despite ambient moisture is crucial. Polyketone has lower hygroscopicity compared to PA6 and PA66 because of the absence of nitrogen in its backbone. In fact, the equilibrium moisture content of Polyketone is even lower than that of long-chain nylons, making it an excellent choice for environments with high moisture levels.

PK ESD: An Eco-friendly Material

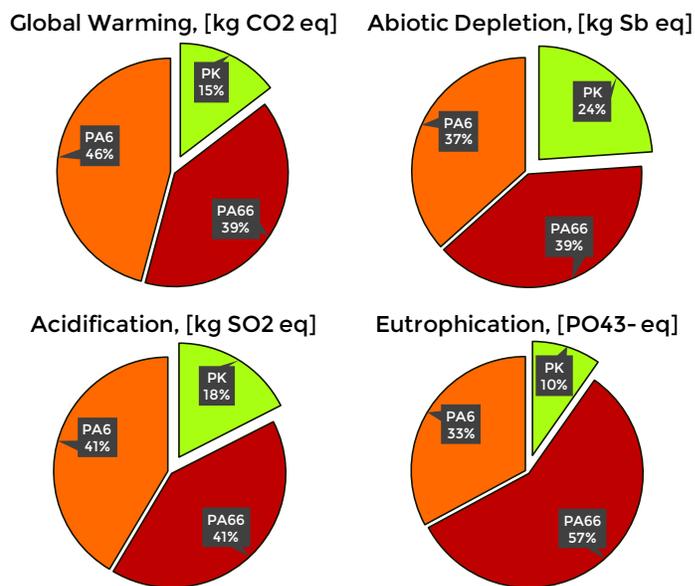


Figure 4: Life cycle assessment of Polyketone compared to PA6 & PA66 (HYOSUN Chemical, September 2020 - POKETONE™ - HYOSUNG Polyketone - Life cycle assessment report).

Table 1: Chemical resistance of PK vs. PA66 & PA12.

	PK	PA66	PA12
Hydrocarbons			
Aliphatic	☐	☐	☐
Aromatic	☐	☐	☐
Halogenated	☐	☐	☐
Ketones	☐	☐	☐
Esters/Ethers	☐	☐	☐
Aldehydes	☐	■	■
Aqueous			
Water	☐	■	☐
Weak Acids	☐	■	■
Weak Bases	☐	■	■
Strong Acids	■	■	■
Strong Bases	■	■	■

☐ Resistant
■ Not Resistant

PK ESD preserves the unique advantages of base PK, which is an eco-friendly and non-toxic polymer (see **Figure 4**). This exceptional material is derived from carbon monoxide and olefins, boasting its unique ability to mitigate carbon monoxide emissions, one of the major contributors to atmospheric pollution. PK demonstrates significantly lower carbon footprint compared to polyamides. Impressively, The Global Warming Potential of PK is over 50% lower than that of polyamides. Moreover, PK's production shows significant reductions in key environmental impact categories when compared to polyamides, abiotic depletion (40% reduction), acidification potential (>50% reduction), and eutrophication potential (>80% reduction).



PK ESD is Reshaping Industries Across the Board

PK ESD Laser Sintering powder has had a profound impact across diverse industries, establishing itself as a transformative solution for electrostatic discharge prevention. In the electronics sector, this material has been successfully employed in electronic housings and tools for electronics shops, resulting in a substantial decrease in equipment failures and a consequent improvement in operational efficiency. In the automotive industry, PK ESD has proven invaluable in enhancing the durability of wear-and-tear parts and improving the reliability of fuel systems.

Aerospace and defense applications have seen notable advancements, particularly in the longevity of jigs, fixtures, and various tools critical for precision manufacturing. The industrial manufacturing sector has witnessed a positive shift with reduced downtime and maintenance costs, while the oil and gas industry has embraced the material for its effectiveness in preventing electrostatic discharge in challenging operational environments.

Moreover, the use of parts fabricated using PK ESD powder has a wide-ranging social implication, both in terms of safety and sustainability. In industries where electrostatic discharge incidents are common, such as electronics manufacturing or explosive environments, PK ESD plays a vital role in ensuring workplace safety. By minimizing the risk of accidents caused by ESD, parts fabricated using PK ESD protect workers from harm, reducing injuries and improving overall productivity. Employees can work with peace of mind, knowing that their safety is prioritized.

In an era where environmental sustainability is paramount, PK ESD powder contributes positively to preserving the ecosystem. Its non-toxic and eco-friendly composition ensures that no harmful substances are released into the environment during parts production and application. By actively embracing this solution, companies and individuals can showcase their dedication to protecting the planet for future generations.



Ready to elevate your business? Mechnano's ESD AM materials offer unparalleled electrostatic discharge protection. Say goodbye to outdated solutions and safeguard your sensitive electronic components with our advanced technology. Join the satisfied customers who have found success with our materials. Contact Mechnano today to discover the power of ESD materials and give your business the competitive edge it deserves. Your success story starts here.

MECHNANO, LLC | 3850 Baseline Rd., Suite 125 Mesa, AZ 85206 | (480) 648-9919 | www.mechnano.com

