

Essentium Z-PCTG

THE CHALLENGE

Essentium Z-PCTG has been developed to solve real challenges present in the manufacturing world, particularly the Electronics Manufacturing Services (EMS) industry. The challenge was essential to create a material that would be ESD safe and did not compromise the other properties of the material, such as printability, cost, temperature resistance, mechanical properties, durability, and migration of material or marring.

SO, WHAT IS ESD, AND WHY IS IT SO IMPORTANT?

ESD (Electro Static Discharge) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown. This rapid discharge can be catastrophic for electronic components and has led those that assemble electronics to take multiple measures to avoid it. For example, all equipment in a PCBA (Printed Circuit Board Assembly) factory will be grounded and those working on a product will wear a grounding strap to ensure they do not discharge electricity through tools directly to the PCB (Printed Circuit Board). Anyone who has visited a SMT (Surface Mount Technology) line will have been asked to wear shoe straps to ground them and most factories now limit admittance to those that pass a grounding test at the point of entry.

THE APPLICATION

WHERE ESSENTIUM-Z PCTG CAN BE USED

There are numerous applications within any manufacturing environment for Essentium Z-PCTG. In the EMS world, any rack, jig, or fixture used to hold a PCB is a candidate. Fixtures machined from solid pieces of material are often less than ideal due to the limitations of milling and machining, such as right angle corners. Another limitation of machining is the outsourced nature of the process, which causes longer than acceptable lead times and a slower than acceptable iteration process. Additive manufacturing allows different form factors to be produced easily, quickly, cheaply, and often onsite and on-demand. Many existing materials are brittle and break easily, especially when dropped. This is particularly problematic when a fixture

or jig is being used in an application where assembly forces are required. Essentium Z-PCTG has greater rigidity, strength, and durability.

Application for additive manufactured parts in a typical EMS facility can be divided into two groups, low and high temperature. The low temperature applications are those around the start of the SMT line, while high temperature tolerances are required for anything that comes in contact with, or in the proximity of, the soldering process, be that reflow, wave, or selective.

APPLICATIONS IN THE EMS WORLD INCLUDE:

- **Assembly Fixtures and Jigs** – Complex form factors can be created at relatively low weights to hold product while manual or machine assembly is taking place;
 - These fixtures are used to support the PCB during lead trimming, inspection processes, routing, washing, paste printing, and conformal coating.
- **Test Fixtures and Jigs** – Complex test fixtures can be built to allow both electrical and mechanical tests to take place.
- **PCB Carriers and Racking** – Custom racking can be easily produced to store and transport PCBs from one location to another.
- **High Temperature Applications** – Where fixtures, jigs, and racks are required around the soldering process, specialty high-temperature materials are required. With typical solder reflow temperature around 260°C, or 500°F, the temperature tolerance of a material becomes extremely important, all while maintaining the ESD safe characteristics.

THE DEMANDS

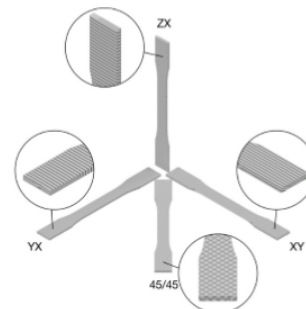
EXPECTATIONS BEYOND ESD

Many materials are modified for ESD applications with the addition of graphite, often in large quantities, between 15 and 25%. While this solves the ESD issues, it compromises the material in other ways, such as causing the rack, fixture, or jig to mar or mark the materials it is designed to protect. The substantial change to the composition of the material also compromises its performance in other ways, such as reducing temperature tolerance, strength, rigidity, and durability. Essentium Z-PCTG was developed to add the ESD protection needed without compromising the attributes of the material:

- **Printability** – Essentium Z-PCTG has the same printable attributes as the non-ESD material it was developed from.
- **Mechanical Properties** - Essentium Z-PCTG maintains its mechanical strength, its durability, as well as its wear and marring characteristics. The lack of migration of material means that it is suitable for use in electronic manufacturing, even in cleanroom environments.
- **Temperature Tolerance** - Essentium Z-PCTG can be used at a wide range of temperatures making it suitable for many processes in production that other materials are not, such as those around the soldering and reflow process.
- **Cost** – A fundamental tenet of Essentium is that industrial adoption of additive manufacturing can only occur when materials and processes can be used economically. To this end, all Essentium materials are engineered to be manufactured economically and at volume.

Metric	Test Method	Molded Properties	3D Printing Properties		
			XY	YX	ZX
Tensile Strength, MPa	ASTM D638	55	38	38	27
Tensile Modulus, MPa	ASTM D638	1748	1670	1507	1426
Flexural Strength, MPa	ASTM D790	68	68	60	53
Flexural Modulus, MPa	ASTM D790	1907	1692	1416	1264
Notched Izod Impact, J/m	ASTM D256	1350	109	29	25

Metric	Method	Properties
Specific Gravity	ASTM D792	1.23
Melting Point, °C	ASTM D3418	202
Glass Transition Temperature, °C	ASTM D3418	76
Heat Deflection Temp., °C		
0.45 MPa (66 psi)	ASTM D648	70
1.80 MPa (264 psi)	ASTM D648	62



THE SOLUTION

HOW IS ESD ACHIEVED?

Essentium Z-PCTG is not the first material to tackle the issue of ESD in the additive manufacturing world, but other materials have come at a high cost, both financially and in terms of compromised performance.

Materials modified for ESD traditionally have a large component of added graphite or carbon black, often between 15 and 25%, this really changes the material and results in several problems and compromises. Many materials with a large amount of added carbon are more fragile, often breaking on impact. These materials also suffer from a severe marring issue, with material transferring from the rack, jig, or fixture to the part being stored or supported. This can also result in air-borne contamination that could find its way into a solder joint or another location that could compromise the performance and reliability of the product. Latent, undetected contamination is particularly dangerous when products are shipped appearing to function well and failing later in the field. The result could be a costly recall.

Essentium Z-PCTG does not add close to that amount of carbon. In fact, Essentium Z-PCTG has less than 5% carbon. Rather than add a large amount of carbon, this high-performance material utilizes carbon nanotubes and is multi-walled, created an equally conductive solution without the compromises in the material's characteristics.

Less carbon can be used because Essentium Z-PCTG is a multilayer extrusion. This means most of the ESD safe or conductive material is close to the surface. This delivers two benefits, firstly the surface is even more ESD safe, and secondly, with little carbon inside, the material has greater tensile strength. This is also the reason Essentium Z-PCTG has the lowest marring or material migration of any comparable material.

THE CONCLUSION

Essentium Z-PCTG delivers a real solution and not a compromise. Essentium's deep domain knowledge in additive materials science and understanding of EMS applications combined with the use of carbon nanotubes allows for the production of a material that delivers the

performance and characteristics of non-ESD safe materials while meeting the ESD need of industry.

The material is extruded and can be delivered economically in volume, both direct and through Essentium's materials partnerships. Essentium fundamentally believe that delivering solutions in machines, designs, and materials that compare well with other manufacturing methods is essential for industrial adoption. This means delivering comparable or superior performance at competitive costs.

Essentium Z-PCTG is available now and is being used by multiple players in the EMS space who report good results and continue to find additional benefits and application for this ESD safe solution.

For more information on Essentium Z-PCTG and other Essentium solutions visit Essentium3D.com or contact an Essentium Materials Genius at Sales@Essentium3D.com.