ESD Open Forum

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Q: In our manufacturing process we make and use various jigs, fixtures, and holders. They often incorporate various forms of plastic and other materials used in conjunction with testers and assembly processes. It is difficult to determine what materials are recommended or even available for these types of applications. Is there a rule of thumb or a list of materials that will work in these types of application?

A: The availability of a “list of plastics and recommended applications” may be obtained from individual manufacturers; however, that would require numerous inquiries to many manufacturers for their recommendations. The following is a list of factors involved in deciding the requirements for fixtures or jigs and the attributes of the materials needed to satisfy those requirements. Table 1 can be used as a rule of thumb or as a general reference and starting point in obtaining the right materials for the application. The table is a compilation of many of the materials and their characteristics that companies are using today for fabricated items..

There are obviously several factors or requirements for plastics when designing assembly and test fixtures. In general they are of the following nature:

1. Electrical requirements if in a tester:
   In numerous electrical testers and fixtures, plastics are used because of their insulating qualities; however, charge generation may enter into the equation. Depending on the requirements, plastics with low % filler content may be high enough in surface resistance (10^9 ohms or 10^{10} ohms) that it might not affect the electrical requirements of the tester but still will dissipate electrostatic charges.

2. Chemical requirements or the resistance to solvents;
   Many fixtures used in the manufacturing assembly processes use chemicals that react with some plastics or the plastic itself can react with some processes. PTFE (Teflon™) is used in many of these applications but it is also high in electrostatic charge generation and may require charge mitigation.

3. ESD requirements if used on ESD sensitive assemblies;
   Many mechanical assembly and test fixtures are used for clamping, locating, and many other assembly processes. Many of the materials used in these processes have a requirement of being dissipative or conductive and grounded to dissipate electrostatic charges as they accumulate.

4. Wear resistance and coefficient of friction;
   From a mechanical perspective, this is a very important characteristic. Many materials may not wear as well as others or they may have a high coefficient of friction that will increase drag if sliding is required, such as when used as rails or guides.

In general, most plastics that have higher moisture absorption will be lower in charge accumulation than those that do not. For example, Polyethylene or Acetal are generally lower in charge accumulation than PTFE. The surface resistance of Acetal for example, when placed in an 80 to 90% relative humidity (RH) for several days will tend to decrease to the high dissipative range. In general, the best materials for making fixtures and jigs would be polymers filled with a conductive material such as carbon, carbon fibers, graphite, graphite fibers, or carbon nanotubes. Metal flakes and fibers as well as some oxides have been added to polymers to reduce the bulk resistance. There are some very good dissipative and conductive sheet, bar and extruded, materials available now that have more of an intrinsically conductive or dissipative base so they may be cleaner in some applications.

The following table represents numerous polymers, applications, mechanical and electrical characteristics. Typical resistances were measured between 25% and 40% humidity and are listed for reference only. The generic names and fillers are subject to change as suppliers develop new products. Good communication with suppliers is required for satisfactory long-term availability of suitable materials.

Table 1: Materials, Applications, and Properties

Brand Name for Reference	**Generic Name / Filler**	**Applications**	**Machinability**	**Surface Resistance Ohms**
Delrin	Acetal (Delrin) Homopolymer 5% to 10 % Carbon , Nanotubes and other additives	Nozzles, Grippers, Guides, Covers, Clamps, Gears	Good	10^4 to 10^9
ULTEM	Polyetherimide Graphite nanotubes	Nozzles, Grippers, Clamps, Locators	Poor	10^4 to 10^6
UHMW	Ultra High Density Polyethylene (HDPE) Dissipative	Guides, Chutes, Rails, Locators	Good	10^5
	Polycarbonate – 15 % Carbon	Nozzles, Grippers, Guides	Poor	10^3 to 10^6
	Polycarbonate – Tunable Graphite nanotubes	Nozzles/Grippers/Guides	Good	10^5 to 10^9
POM	Acetel (POM) 20% Carbon Powder	Guides, Chutes, Rails, Locators	Fair	10^2 to 10^6
Vespel	Graphite Polyimide	Nozzle Bodies & Guides	Fair	10^4
Semitron	Polyetherimide	Nozzles, Grippers, Locators	Fair	10^3
Acetal	Polyoxymethylene (POM)	Guides & gears	Good	10^4
	Peek Carbon Fiber	Guides, Chutes, Rails, Locators, covers	Poor	10^4
EFI	Urethane, Dissipative	Dissipative Foams	poor	10^8
Royalstat	ABS/PVC Carbon Powder / Graphite Fibers	Covers, chutes, slides,	Fair	10^4
Cerastat	Ceramic	Locator pins, Nozzle Tips and Tips	NA	10^4

Cermax	Ceramic	Locator pins, Nozzle Tips and Tips	NA	10^6

As shown in Table 1, the filler in many cases affects the machining capabilities of the materials. Carbon fibers tend to tear and break and leave a rough surface. If a smooth surface is important in the application, then carbon or graphite powder may be better to use. This is an example of what needs to be discussed with the supplier. The range in resistance in some of the materials is a result of the blend process and the actual percentage of filler added.

Many of the materials listed in Table 1 are available in sheet form, extruded rod of many sizes and special sizes can be ordered, although minimum quantities are often required. An important consideration and discussion to have with your suppliers is the hardness and brittleness differences of sheet stock, extruded stock and plain stock. The different processes can alter these characteristics making a difference in wear characteristics.

Usually injection molding of parts is not a requirement for fixtures and jigs due to the limited quantities required. However, through commercialization of standardized fixtures and jigs, some parts may be injection molded and should have the ESD requirements specified during the design phase. Unfilled materials and filled materials do not mold the same and usually the molds are different due to different shrink rates. Molding of these materials may also change the hardness or brittleness of the materials.

With all of the materials and compounds available today, unless a process has some rather unusual requirements, most fixture and jig designs can incorporate the proper materials to afford the best ESD control for the applications. A good starting point in an internet search is to look for “ESD Plastics”. Table 1 above should help you get started in your search for fixture and jig fabrication materials.

References:

D. Bellmore, “Controlling ESD in Automated Handling Equipment,” EOS/ESD Symposium Proceedings, ESD Association, Rome, NY, September 2002.

Machinery Handbook, 24th Edition

About the Author:

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