Choosing the Right Bag

BACKGROUND

Almost everyone is aware of the effects of static electricity in general terms. Scuffing one's shoes on carpet and touching a person or metal door handle produces a brief shock. Drying synthetic clothing in a cloths dryer will often produce "static cling". The static electricity behind these common events can destroy modern electronic circuits and devices.

As electronic circuits and their connecting pathways have continued to shrink in size, their susceptibility to damage from static electricity has increased. A factor of 10 shrinkage in feature size can make gate oxides 10 times more sensitive. Protective handling and packaging techniques have been adopted by all segments of the electronics industry from the chip foundry to the production floor to the field service arena.

BAGS

One of the most common static preventative items is a bag. The use of protective bags began in the 1960's with the introduction of "pink poly" bags. Static shielding bags were introduced in the late 1970's. And while the military has long used moisture barrier bags, the proliferation of Surface Mount Technology has greatly increased usage.

STATIC THREATS

A device needs to be protected from three primary static threats:

Direct Discharge (ESD): A discharge directly to a bag can subject the device inside to very high current, melting or fusing the circuit.

Static Fields: Fields can induce destructive currents in circuit conductors. Field differentials can break down the circuit dielectric.

Tribocharging: Friction between the bag and device can produce damaging static voltage and fields.

TESTING OF PROTECTION

The Static Shielding test, EIA 541 Appendix E, applies a direct discharge to a bag. See Figure 1. An oscilloscope connected to a sensor inside the bag measures the amount of voltage that penetrates the bag. This test also addresses the Field threat. Fields are generated by the discharge to the outside of

the bag. Fields that penetrate the bag are represented in the voltage measurement.

Tribocharging tests are difficult to perform and are not very repeatable. Data from bag specs are only a benchmark, and do not describe how a materials will perform in use. Bag users are left to compare these benchmarks or perform their own tests.

Surface Resistivity is an indication of a material's ability to allow static to move around (dissipate). It is does not necessarily suggest low tribocharging.

ATTRIBUTES

Below, the protection abilities, construction, and applications of several of the most common bag types are described. The terms section that follows the bag descriptions may help to clarify some of the words used in the descriptions.

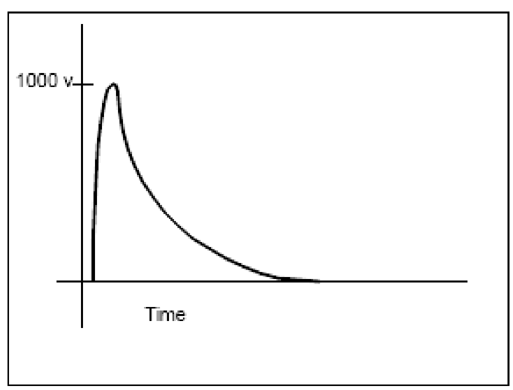

Figure 1. ESD Pulse applied to bag in EIA shielding test.

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'PINK' POLY BAGS OR DISSIPATIVE POLY BAGS

Abilities: The bag has the ability to dissipate a static charge to ground. This keeps charge (static electricity) from building up on the package or the device. The material is also antistatic, suggesting that it will not charge up (tribocharge) when rubbed against other materials. The material's resistivity is in the dissipative range and is usually about 10^9 to 10^{11}. Unfortunately these bags have no shielding ability. A static field or discharge occurring outside the bag will penetrate the bag and damage electronics inside. The graph below shows the penetration of a dissipative poly bag by electrostatic discharge (ESD). See Figure 2.

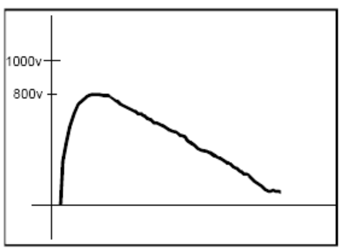

Figure 2. ESD that penetrates a poly bag.

Construction: Pink Poly bags consist of polyethylene (plastic) that has been loaded or surface coated with a chemical antistat. See figure 3. The pink color of

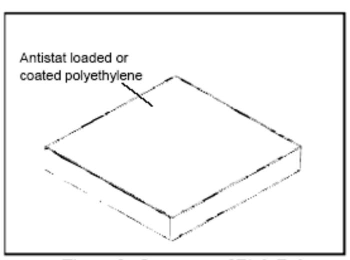

Figure 3. Structure of Pink Poly.

"pink poly" is only a colorant that was added to differentiate static control materials from standard packaging. (Pink poly is transparent) Many users are now asking for clear dissipative poly bags. In the past, a reactive form of amine was used in the chemical antistat. This antistat caused oxidation of some metals and stress cracking in some plastics. The pink color is some times incorrectly associated with this amine type antistat. Some manufacturers switched to amide based antistats and removed the pink color in response to customer requests.

Applications: Pink Poly bags are useful for packaging items that have no static susceptibility. Their primary use is to package support or processing material that will be in close proximity to static sensitive devices. This keeps static generating packaging materials away from sensitive areas. Poly bags are also known as "TYPE II" bags from the U.S. military standard MIL-B-81705.

BLACK CONDUCTIVE POLY BAGS

Abilities: Black Poly is very conductive, usually about 10^{3-4}, and will dissipate a charge very fast. Unfortunately this fast dissipation also means that a charged person or object can 'spark' (ESD) to its surface. The general idea in static control is to swap charges at a slow enough rate to avoid sparks. But not too slow so as to allow a static build up. Because the material is conductive it does provide some small measure of shielding (<30%). However there is no plastic layer (dielectric) to isolate a device inside a bag. The charge may be transferred through the volume of the material to the device instead of around the material to ground.
See figure 4.

Construction: Black Poly bags are a polyethylene plastic that is volume loaded with a conductive

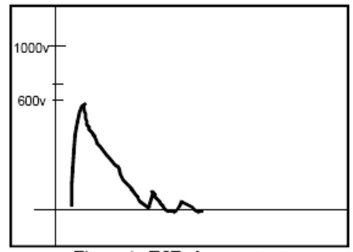

Figure 4. ESD that penetrates a black poly bag.

form of carbon. The material is black and opaque in appearance. Figure 5.

Applications: In the past, black poly was used as a bridge between pink poly and shield bags because of slightly lower cost and offering some shielding as opposed to none with pink poly. However, as the price of shield bags continues to drop the usage of black poly will likely drop as well. Because black poly bags are opaque, the bag's contents must be removed for identification. This creates a new opportunity for static damage.

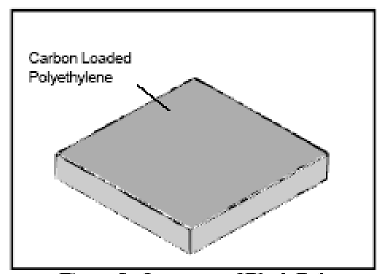

Figure 5. Structure of Black Poly.

SHIELDING BAGS

Abilities: Shield bags provide the dissipative and antistatic attributes of the poly bag but add a metal shield and polyester dielectric to stop static from entering the bag. The test for shielding demonstrates the difference between the various bags. Shield bags will generally stop 97% of a 1000 volt static pulse applied to the outside of the bag from reaching the inside. Pink poly will stop only about 10% and black poly out 30%. See figure 6.

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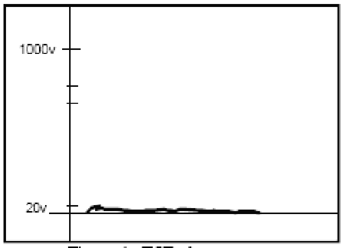

Figure 6. ESD that penetrates a static shield bag.

Construction: Static Shielding bags consist of several layers. From the interior to the exterior the layers are: dissipative poly laminated (glued) to metalized polyester. The outside polyester has an antistat coating. The metal is vapor deposited in a vacuum chamber. Aluminum is the metal most used in this process, with nickel and copper also being used.

This structure of a shield bag, with the metal between two layers of plastic, is called "buried metal" or "metal-in".

In a "surface metal" or "metal-out" structure, the poly is laminated to the polyester with the metal on top. There is an abrasion coating on the metal. The metal generally used is nickel and it is sputtered instead of vapor deposited.
See figures 7 and 8.

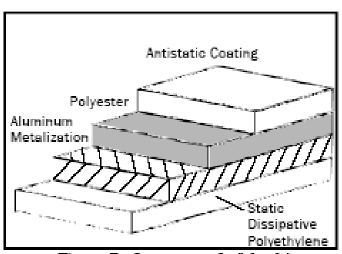

Figure 7. Structure of a Metal-in shield bag.

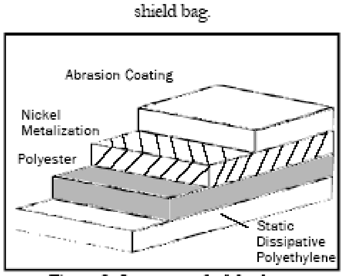

Figure 8. Structure of a Metal-out shield bag.

The metal-in or buried layer bag offers better protection of the transparent metal shield by placing it between two plastic layers. The surface metal bag has a conductive outer surface which provides fast charge dissipation. However, like the black poly bag, it can be sparked to.

Applications: Static shield bags should be used for all electronic components, boards and assemblies. Shield bags are referred to as TYPE III under MIL-B- 81705C.

MOISTURE BARRIER BAGS

Abilities: Moisture barrier bags provide dissipation, antistatic properties, static shielding, and add a moisture vapor barrier. The moisture barrier protects moisture sensitive items and improves long term storage.

Construction: This type of bag is physically stronger than a shield bag. Moisture barrier bags are similar in structure to the shield bags. The two types are "foil and tyvek" (figure 9) and "heavy metallization".(figure 10)

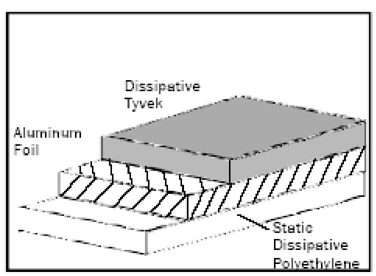

Figure 9. Structure of Foil Barrier.

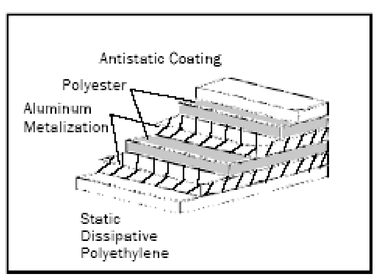

Figure 10. Structure of Metalized Barrier.

The "foil and tyvek" structure from the interior to the exterior is: dissipative poly laminated to thin aluminum foil and tyvek. Tyvek is Du Pont spunbonded poly-ethylene material. The "heavy metallization" structure is essentially that of a shield bag but with opaque, thick aluminum metallization or multiple layers of metallization. Nylon may be used in place of Tyvek or polyester. It provides the needed strength at a lower cost than Tyvek. Both foil and metalized moisture barriers provide good service.

Applications: The moisture barrier bag is used when barrier protection is needed or when maximum shielding protection is desired but transparency is not an issue. Surface mount devices are placed in moisture barrier bags to avoid moisture absorption by the IC case material. During reflow soldering, absorbed moisture will expand and crack ("popcorn") the case. The moisture barrier bag is also referred to as MIL-B- 81705 TYPE I.

SUMMARY

Static protective bags are an integral part of a static control program. Selecting the appropriate bag can help reduce static damage and save money on costly repairs and rework. One company saved over $200,000 and experienced a 30 to 1 ROI in one year by replacing pink poly bags with shield bags.

The cost of static protective packaging is insignificant when compared to the protection it affords the costly items placed in the package.

Bagging guidelines in general are:

- Use static shielding or moisture barrier bags for all electronic circuits.

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- Use pink poly for non-electronic parts and production goods that must be near electronics.
- Bags alone can not provide complete static protection. A program using grounding technique and static handling procedures is a must.

Bag Sourcing:
Topics to remember when sourcing bags include:
- Buyer be aware. The least expensive bag may not be the best investment. Look for a product that works above all else. Materials and bags should be tested by the manufacturer before shipping. Look at a potential supplier's quality program, material traceability, and testing abilities.

- Next, consider supply stability and delivery.
A low cost bag that is not available when you need it not a bargain.

- A large selection of standard sizes, (more than 100) will keep you from paying for custom sizes.

- Look for technical depth to support the product. Finally, after these issues are addressed, consider the price.

<u>TERMS</u>
<u>Electrostatic Charge</u> is an electrical charge at rest. At rest as compared to direct current (dc) moving through a wire.

<u>Electrostatic Discharge (ESD)</u> is the transfer of static charge between two objects at different potentials.

<u>Electrostatic Discharge Sensitive (ESDS)</u> refers to a device that is sensitive to ESD.

An antistat is a chemical that makes a surface able to resist charging. Most antistats, when applied to plastic, attract water (humidity) from the air creating a moisture layer on the surface of the plastic that can conduct electricity. Some more modern antistats contain different chemical arrangements that carry their own water with them. A combination of these chemical antistats is also used.

Creating a charge on objects by rubbing (fiction) and separating them is call Tribocharging. An example of tribocharging is when a person walks across a carpet and then sparks (ESD) to a door knob. The person's contact and separation with the carpet charged them.

The term antistatic refers to a material's ability to resist generating a charge by friction (tribocharging). Antistats can create an antistatic surface by increasing the surface's lubricity (slipperiness).

Static Dissipative materials can conduct static across their surface or through their volume to a ground point.

Surface Resistivity Ranges. For static control, a material's resistivity classifies its use. Insulative materials have a resistivity of more than 10^{12} ohms and should not be used.

Dissipative materials have a resistivity of more than 10^5 and less than 10^{12} and should be used for intimate contact with electronics. Conductive materials are defined as having a resistivity of less than 10^5. However, to be considered static shielding they should, in practice, have a resistivity of 10^2 or less. Shielding materials will shield electronics from electrostatic voltages and fields.

Please note that these ranges apply to static control and not to general electronics. The ranges (except for the 10^2 shielding value) are from the EIA 541 and from the U.S. military MIL-HDBK-263.


PINK POLY BAG


BLACK CONDUCTIVE BAG


STATIC SHIELDING BAG


MOISTURE BARRIER BAG

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