P2 Selecting a Moisture Barrier Bag

Before selecting a barrier bag, we need to examine test methods, barrier technologies, bag structures, and performance considerations.

Basics

Surface Mount Devices (SMD's) are mounted to printed circuit boards by reheating solder on the pads. This technique, called reflow soldering, heats the circuit board, device leads, and the device case. Moisture trapped inside the device case expands at a rate faster than the case causing the case to rupture. Broken cases may cause immediate failure of the device, or may cause damage to the device that becomes appearent after the device is in use.

SMD's must be either kept dry or slowly heated under very controlled conditions to drive off accumulated moisture. Before shipping, dry rooms are used by device manufacturers for storage. Devices shipped without low moisture packaging must be baked in controlled conditions specified by the device maker. This can take 24 hours, delaying production, and necessitating equipment that can control temperature and humidity.

The need to keep SMD's dry between the time of manufacture and the point of reflow soldering has driven the development of moisture barrier bags. Also known as vapor barrier bags, these bags are made from multiple layers of plastic and aluminum that control moisture vapor leakage.

Barrier bags are not moisture vapor proof nor do they remove moisture. Over time, moisture vapor will leak into the bag.

Moisture barrier bag with HIC and Desiccant

Desiccant is put into the bag to reduce humidity and scavenge moisture that penetrates the bag.

A humidity indicator card (HIC) may also be put into the bag. HIC's indicate the relative humidity with moisture-sensitive, color-changing chemical spots. HIC's provide assurance to the user of the bag that the devices are dry when received.

As a final moisture impediment, vacuum is used to remove air-containing moisture before the bag is heat-sealed. (See SCC Technical Bulletin P3 for more information about the dry packaging process.)

Tests and Test Methods

Several tests are important to describe moisture barrier bag performance. Resistance to moisture penetration for a barrier material needs to be defined. Also, the bag must be free from pinholes and voids in the side seams. This leads to a bag integrity test. Finally, the bag must be strong enough to resist puncture from trays or reels of devices.

Static Control Components developed this Technical Bulletin to assist users with understanding, acquiring, and implementing static control measures. Bulletin P2 provides guidance for selecting moisture barrier bags. Further technical support can be obtained from other Tech Bulletins, Product Data Sheets, and Static Control Components' Technical Staff.

MVTR

Moisture Vapor Transmission Rate (MVTR) is the rate that water vapor passes through a specific area of barrier material. As MVTR is reduced, dry storage time is increased and desiccant loading is reduced. MVTR is measured in grams of water vapor, per 100 square inches of barrier, per 24 hours (g/100in2/24hrs).

There are two primary test methods for MVTR:

ASTM F 1249
In this test, a sample of barrier material is placed between wet and dry compartments. Infrared light is used to detect water vapor leaking through the barrier material. Complete barrier bags can also be tested. The sealed bag is placed in a large container. Probes inside the container and bag allow the MVTR to be accessed. This test is also known as a MOCON test after an equipment maker.

Moisture Vapor Test Equipment.
(Courtesy of MOCON)

Federal Test Method Standard 101 Method 3030
(FTMS 101 MTH 3030)
A sealed barrier bag with a desiccant pouch inside is weighted and placed in a chamber at 100^{o}F and 90% relative humidity for 64 hours. Weight gain of the bag indicates moisture gain. Using weight, bag area and time, the MTVR can be calculated.

Which Method?
Advocates of MTH 3030 claim that ASTM F1249 can not measure low enough MVTR for foil barrier bags. Champions of ASTM F1249 disagree, adding that MTH 3030 allows too much variation in procedure and is too technique sensitive to produce results that can be compared from lab to lab. While a definitive study has not been produced, virtually every moisture barrier bag supplier reports data from ASTM F1249 testing.

Samples are Important
Whether a flat sample or bag is tested, the material tested should be from a factory made barrier bag. The process of bag making can degrade barrier properties. Some bag users require barrier bags to mechanically flexed using a Gelbo Flexor prior to testing. This procedure is described in FTMS 101 MTH 2017.

Bag Integrity Tests

Military standards 117 and 116 describe general procedures for making bags. In MIL-P-116, techniques for leak detection are specified.

Submersion. FTMS 101 MTH 5009 is a test method for finding leaks in bags. A bag is inflated and sealed. The test operator submerges the bag in water and applies pressure to the bag. Air bubbles coming from the bag material or seals indicate the location of any leaks. MIL-P-116 does not allow any leaks.

Hanging Weight. FTMS 101 MTH 2024. This method stresses a 1-inch segment of the bag's side seam with a 3.5 pound hanging weight. MIL-B-81705 refers to this test method and allows no separation of the sealed material.

Puncture Resistance. This test challenges a material's resistance to puncture with a steel probe. MIL-B-81705 requires a minimum of 10 pounds resistance. In the test method FTMS 101 MTH 2065, a specimen of bag material is placed into a flat cage with a hole through the center. A 5-inch long rod with a 1/8-inch radius is pushed through the bag material using an Instron tensile tester. An electronic load cell measures the force (in pounds) required to puncture the material.

Barrier Technologies

Two primary moisture barrier technologies are used for bags. Barriers of aluminum foil and aluminized polyester are used where low MVTR is required. Most SMD's are packaged in a metal barrier bag. Thick layers of plastic can also be used to provide limited barrier for very short-term applications.

Foil/Polymer

This is the oldest and highest barrier technology. A thin sheet of aluminum foil (usually about .00035 inches thick) is laminated to nylon or Tyvek for support and protection.

Aluminized Polymer

This newer technology reduces material cost. Aluminum is vapor deposited onto polyester. The metal is so thin that multiple layers of aluminized polyester are laminated together. Voids in one layer are covered by another.

Engineered Polymer

Clear plastics that do not use metallic layers provide limited moisture barrier. Their primary use is for food packaging. Applications in electronics tend to be very short-term dry storage and clean room situations. Clear barrier bags do not meet the electrical or MVTR requirements of MIL-B-81705C.

Moisture Barrier Bag Structures

(see also SCC Tech Bulletin P1, Selecting Static Bags)

Nylon/Foil/Poly

Typically, this structure consists of a 60 gauge nylon laminated to 0.00035 aluminum foil, which is laminated to heat sealable polyethylene. See Figure 1. This is the most common foil/polymer laminate. MVTR for this structure, when properly converted into bags is very low at about 0.0005 g/100in2/24hrs[1].

Tyvek™/Foil/Poly

This structure consists of a Tyvek, laminated to 0.00035 aluminum foil, which is laminated to heat sealable polyethylene. Tyvek is a white, textured sheet made by spinning hot plastic onto a moving belt. White plastic shipping envelopes are made from similar materials. Tyevk Foil is the oldest barrier structure and has with few exceptions been replaced by nylon/foil or metallized polyester struc-

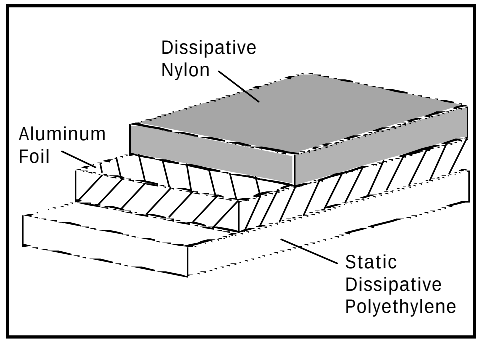


Figure 1. Structure of Foil Barrier.

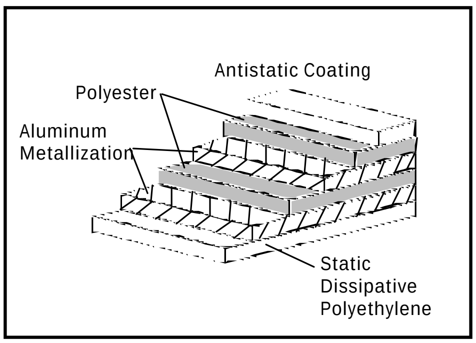
Nylon/Foil Barrier Bag

Tyvek/Foil Barrier Bag

tures. MVTR for this structure, when properly converted into bags is very low at about 0.0005 g/100in2/24hrs[1].

Aluminized Polyester/Poly

Typically, this structure consists of two layers of 48 gauge-aluminized polyester laminated to sealable polyethylene. See Figure 2. This is the newest technology for barrier materials. These lower cost bags are a big success with the medium to short term dry packaging users. For 3.6 mil materials, MVTR is about 0.02 g/100in2/24hrs*. Structures that are 7.0 mils thick can achieve 0.005 g/100in2/24hrs[1].



Structure of Aluminized Polyester Moisture Barrier Material.

Aluminized Polyester Barrier Bag

Other Performance Considerations

ESD Properties

Moisture barrier bags should provide dissipation, antistatic properties, static shielding and some measure of EMI/RFI attenuation. The generic specifications in Table 1 should be met.

Table 1 . Static Control Properties

Surface Resistance (interior/exterior): ANSI-EOS/ESD S11.11	$<1.0x10^{11}$ohms
Static Shielding: EIA 541 Appendix E	<30 volts
- or -	
EOS/ESD S11.31	<10 nanojoules
Tribocharging: EOS/ESD ADV11.21	Lower than virgin poly film
EMI/RFI Attenuation: MIL-B-81705 Type I	>25dB

Meeting the Standards

MIL-B-81705 Type I "*Barrier Materials, Flexible, Electrostatic Protective, Heat Sealable.*" This standard provides test methods and limits for MVTR (0.02), mechanical, and electrostatic properties for barrier materials.

While the standard is comprehensive, it requires special military printing and lab qualification that add to barrier material cost and do not contribute to material performance. A material that "meets the requirements" of MIL-B-81705 (as opposed to a material on the Qualified Products List (QPL)) should suffice for all applications except military or military contractor. Both foil and aluminized polyester structures are listed on the QPL.

EIA 583 "*Packaging Material Standards for Moisture Sensitive Items*" defines a 'Class 1' barrier as having a MVTR of <0.02 g/100in2/24hrs. A 'Class 2' barrier is set at <0.08 g/100in2/24hrs. EIA 583 also sets a puncture limit at 10 lbs and provides desiccant loading calculations. (See SCC Tech Bulletin P3 for desiccant loading information.)

EIA/JEP 124 "*Guidelines for the Packaging, Handling and Repacking of Moisture-Sensitive Components.*" This document is little more than "EIA 583 Lite." It provides some general suggestions regarding vacuum sealing, receiving, and repacking barrier bags.

Thickness

Each manufacturer of bags offers a material structure that is a little different. Usually, this difference is the thickness or gauge of the barrier material. Barrier bags are available in thicknesses of 3.2, 3.6, 4.0, 5.0, 5.5, 6.0, 6.1, 7.0, and 10 mils (one mil equals 0.001 inches). In general terms, only large thickness differences change bag performance and cost. Three gauges are somewhat standard; 3.6, 6.0, and 10 mils.(Tyvek) If we compare different gauges of the same structure, thicker materials usually provide greater puncture resistance. Let's use an aluminized polyester structure for example. A 3.6 mil material will have a puncture resistance of about 20 lb/in. A 7.0 mil version of the same structure may exceed 32 lb/in.

MVTR

Industry standards require an MVTR of <0.02 g/100in2/24hrs. A lower MVTR will provide low interior humidity for a longer period.

For example, a 16"x18" barrier bag with an MVTR of <0.02 g/100in2/24hrs, and a maximum interior humidity (MIH) of 20%, sealed for 12 months, requires 6.6 units of desiccant per EIA 583. A bag of the same size and conditions with an MVTR of <0.0003 g/100in2/24hrs, requires only .01 unit of desiccant.

This illustrates the difference in MVTR values. It also shows that desiccant costs can be reduced by using a bag with lower MVTR. Of course, bags with lower MVTR are more costly.

Bag Supplier

It may seem a bit odd to discuss suppliers here. However, the best barrier material can be rendered useless by leaking side seals or holes in the bag. Consider that barrier materials require special handling to avoid pinholes, and proper bag converting equipment to heat seal thick barrier materials. Your supplier should perform some type of bag integrity testing on an ongoing basis.

Seeing is [not always] Believing

This common sales technique is used to extol the benefits of multi-layer aluminized barrier bags.

A user of foil barrier bags is asked to look inside the bag with the bag placed tight against their face, so that the interior of the bag is dark. The user sees pinpoints of light showing through the bag. Upon repeating the 'test' with the aluminized barrier bag, the user sees no light inside the bag. Mr. Salesman explains that foil bags have 'pinholes' and aluminized bags do not.

The truth is that both aluminized and foil barrier structures allow light to penetrate at points where the metal has been flexed. These flex points cannot be seen inside aluminized bags because the overlapping layers hide the flex points.

Proper testing shows that the passage of light and the passage of moisture are not equivalent. MVTR testing after Gelbo flexing, which creates hundreds of pinpoints of light, shows that foil laminates have lower MVTR's as compared with aluminized structures.

'Pinholes' holes are tiny openings that pass through the plastic and metal. Debris trapped between the wraps of barrier material usually cause pinholes when the material is wound on a roll.

Selecting a Moisture Barrier Bag

The list of items to consider when selecting a barrier bag is substantial. MVTR, puncture, term of usage, cost, ESD properties, supplier reliability must evaluated.

Table 2 will help you compare the choices.

By
Brent Beamer~SCC

Table 2. Barrier Bag Comparison

Material	Gauge	MVTR*	Puncture Resistance	Cost Comparison
Units	(mils)	$(g/100in^2/24hrs)$	Lbs.	
Clear Barrier[2]	5.0	.1 to .05	20	$+
Aluminized Polyester	3.6	.04 to .02	17-20	$
Aluminized Polyester	7.0	.009 to.005	>30	$$+
Nylon/Foil	6.0	<.0003	18-22	$$
Tyvek/Foil	10.0	<.0003	17-19	$$$

1 Tested per ASTM F1249. Flat specimens cut from machine made bags.
Tyvek™ - Du Pont Trademark
2 Clear barrier bags do not meet the electrical or MVTR requirements of MIL-B-81705C.

Static Control Components, Inc.
ESD Products Division

US and Canada **800.356.2728** Fax 800.356.2729
International 919-774-3808 Fax 919-774-1287 3010 Lee Avenue Sanford, NC. 27331 USA
Internet: www.scc-inc.com email: esd@scc-inc.com