Technical Bulletin 31

Developed by Alcatel Lucent Bell Labs to fight the dual problem of Corrosion and Static Electricity

Designed to Save you Money from expensive losses due to ESD or Corrosion

Static Intercept is a revolutionary technology which uses semi-conductor technology to transform standard plastics into semi-conductor devices capable of protecting even the most sensitive electronic device. Static Intercept is the *'State of the Art'* technology for the protection of static and corrosion sensitive materials. Intercept was developed by Alcatel Lucent Bell Labs to solve the problems the electronics industry was experiencing with static and corrosion damage. Intercept is available in a wide variety of packaging, storage and material handling products.

Corrosion Inhibition:

Corrosion on circuitry can be confined to mainly three main factors - atmospheric corrosion of the metals, galvanic corrosion, and fungus attack. We will handle each in turn.

Atmospheric corrosion is one of the most prevalent and most easily recognized and understood forms of corrosion. Atmospheric corrosion occurs whenever atmospheric gases attack a metal surface. Metals corrode (tarnish) by reaction with common gases in the atmosphere. These corrosive gases react with both Ferrous (Iron based) and Non-Ferrous metals, however these gases are the primary cause for Non-Ferrous metal (such as Silver, Tin, Copper, Brass, etc.) corrosion, though they are still extremely significant in Ferrous corrosion as well.

The common corrosive gases and examples of how they are produced:

- Hydrogen sulfide (H_2S) produced as affluent from pulp mills, oil refineries, heavy industry and from decaying vegetation.

- Carbonyl sulfide (COS) produced from fossil fuel combustion (such as burning coal, gasoline or petrol, oil, etc.), wood fires and ocean surfaces.

- Sulfur Dioxide (SO_2) produced from fossil fuel combustion and from smelting operations.

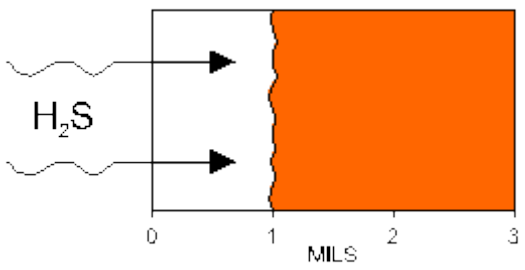
- Hydrogen chloride (HCl) produced from fossil fuel combustion and ocean surfaces.

- Ozone (O_3) produced as a byproduct of combusting fossil fuels.

Metals in nature always assume their most stable state, which in most cases are sulfides, chlorides, oxides or other salts. However, for metals to be used in electronics, as well as for cosmetic applications, these metals are refined and purified. Once the metal has been purified it can conduct electricity. However, purified metals are unstable and seek to react with corrosive gases - which are also chemically unstable. According to Rebecca Starling of General Dynamics:"90% of the trouble with corrosion in missiles originates on the drawing board. To be certain of adequate protection from corrosion, the designer must anticipate conditions during inert life (transportation, storage, rework, and repair) as well as during active operation. The designer's responsibility is (1) ascertain the environmental extremes likely to be encountered - and (2) to provide corrosion protection against these conditions."

We need to recognize the fact that metals begin corroding as soon as they are exposed to the environment. We need to prevent the contact the metal has with the environment. We also recognize the fact that the most sensitive time for a metal is when it is inert. This is because once electricity is flowing through a metal, once the metal or circuit is active, the likelihood of corrosion drops significantly. It drops significantly because the metal is now temporarily being chemically altered by flowing electricity. This change makes the reaction with a corrosive gas more difficult (less driving force) and hence far less prevalent or likely. In storage, shipment or manufacture, the circuit and the metals are not active and are targets for corrosive gas attack.

Corrosive gases are extremely active, more active as the temperature increases. Everything in nature seeks to be chemically (electrically) stable. Gases seek the path of least resistance, or in other words, seek the path with the highest driving force. Since metal surfaces are an ideal site, the surfaces must be protected. Intercept provides protection by being a preferential corrosion site. The gases find reacting with Static or Corrosion Intercept to be easier (higher driving force), so they naturally go to the Intercept. Intercept is preferential because of a combination of high level of surface area of its reactive components an also because of the chemical changes done to these Intercept active sites. By enclosing a metal object in Intercept, the Intercept creates a micro-environment cleansing the air of these reactive gases. By minimizing the exchange of air in the package, the Intercept continues to provide this clean micro-environment on the inside. Meanwhile, the Intercept protective enclosure prevents new corrosive gases from penetrating through the Intercept - at 7 ppb it takes Sulfur 10 years to penetrate .001" of Intercept.



This testing is the same whatever the substrate that the Intercept is coated onto. The corrosion protection is directly tied to how much Intercept is available - how thick the coatings are. The thicker the coating, the longer the protection, on any substrate.

One misconception of corrosion is that it is caused by water. Water does act as an excellent carrier for these corrosive gases and reactive ions. Ions are easily dissolved in water and are then carried by humidity, water vapor and steam. Water also acts as an accelerator - increasing the reaction rate of these gases and ions with the metal surfaces. However, water of and by itself does not cause corrosion - its what is in the water that does the damage. Intercept helps counteract these ions and water borne contaminates - for water permeating an Intercept film.

One of the other major types of corrosion, especially for Ferrous metals, is galvanic corrosion. Galvanic corrosion is caused by the junction of two dissimilar metals. "Galvanic corrosion is caused by a flow of electricity from one metal to another or to a recipient (i.e. soil) of some kind, or from one part of the surface of the metal to another part. Differences in the metal can be seen as composition of the metal itself varying, or differences in grain boundaries, or localized shear or torque from the manufacturing process. Almost any lack of homogeneity of the metal surface or its environment may initiate a galvanic corrosion attack, by causing a difference in potential. Contact between dissimilar metals also causes this galvanic current to flow, due to the difference in potential of the two, or more, different metals." . The relative passivity of stainless steels or other metals or alloys is due to a presence of a corrosion-resistant oxide film on their surfaces. In most natural environments, such metals remain passive to corrosion but can still cause galvanic corrosion. This passive state for stainless steel can be changed to an active state (can corrode) when Chloride concentrations are high, such as in or near seawater (ocean travel or manufacturing within 25 miles of an ocean surface). So, galvanic and atmospheric corrosion can easily co-exist in severe environments, even with materials that are corrosion resistant.

Intercept is one of the few materials that is effective against galvanic corrosion. Circuit boards normally have several different metals - such as Copper, Tin, Silver, etc. These metals are at different levels in the galvanic series, so they will react with each other. Intercept, being a semi-conductor material has an activation threshold less than the galvanic current for these metals. When Static Intercept is in intimate contact with these metals the galvanic current is shunted to the Static Intercept - Intercept breaks the electron path between the dissimilar metals. Intercept acts as a sacrificial anode, protecting the galvanic couple and lengthening the life of the circuit board because it is protected during process, shipment and storage.

Microbial attack came to widespread notice during World War 2 when so much damage was done by fungus in the South Pacific. Although they thrive best in warm, humid environments, fungi can exist under cold or dry conditions. As more non-metallic materials are used in electrical and electronic assemblies, increased attention must be

devoted to protection from fungal attack. In one large missile system, over 200 items were found to support fungus growth. However, the prevention of fungal attacks on circuit boards and their substrates is difficult. Even the use of materials that do not support fungal growth may not solve the problem because fungi can exist on a given material without feeding on it, creating an undesirable film deposit on the material.

Intercept can also protect against this fungal attack. It is a well documented fact that Copper in the proper form can retard fungal and microbial growth. Intercept, with its core of activated Copper, acts as a passive fungicide. Intercept will not actively kill the fungi, however Intercept will interfere with its growth and reproduction, ultimately killing the fungi. The micro-environment created by Static Intercept will be fungi free within a relatively short period of time increasing protection for past being transported to or from Asia, and other hot, humid locations.

Intercept provides the three layers of protection.

(1) protection from atmospheric corrosion

(2) protection from galvanic corrosion

(3) protection from fungi attack

Companies using Static Intercept have reported substantial decreases in latent defects (caused almost exclusively by corrosion and ESD) as well as in work in process failures (WIP materials) leading to increased yields. Intercept is safe and effective for direct wafer contact, as well as for storing and shipping boards, assemblies, missile components, and irreplaceable art works.

By preventing corrosion on the circuits the useful life of the circuits will be extended. By eliminating corrosion soldering problems can be completely eliminated - this is a major benefit for board, circuit and component manufacturers. Finally, latent defects are a major concern for all levels of electronic assemblies. Bell Labs determined that corrosion plays an extremely significant role in causing latent or field defects.

Corrosion cripples a circuit by reducing the conductive paths that the electricity has to flow over. As metals corrode they go from being conductive to insulative. This is a chemical change that steals productive life from the electronics. The thinning of the conductive paths, due to spots and fingers of corrosion, also reduces the heat dissipating properties of the metal. Corroded metals cannot dissipate heat like a conductive or pure metal can. This reduction of the heat dissipation leads to a build up of heat on the conductive paths and eventually a burn through, rendering the conductive path, and the circuit worthless. By using Intercept the conductive paths are protected during the time when the circuit and electronics are most susceptible to damage - namely manufacturing, shipping and storage. The secret is protecting the part during these critical times.