



CORROSION INTERCEPT

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Technical Bulletin 29 Corrosion Intercept Paper Preservation



By Appointment
to Her Majesty Queen Elizabeth II
Suppliers of Conservation Storage,
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Developed by Bell Labs to solve their various corrosion problems. Intercept is the state of the art in Corrosion protection, providing unequalled and unsurpassed protection.

Intercept is a revolutionary new patented technology which uses semi-conductor technology to transform regular plastic into a protective reactive barrier against corrosive gases, fungus and bacteria. Paper and paper products decompose by reacting with corrosive gases such as Ozone, COS, SO₂, HCl, NO₂ and H₂S. These corrosive gases are formed by decaying vegetation, burning fossil fuels, industrial output, ocean surfaces, degrading packaging and mating material, as well as other natural sources which include being released from traditional packaging systems, paperboard, plywood and chipboard. These gases are in every environment, even inside Lucent Technologies cleanroom facilities which have sophisticated filtering systems to remove microscopic dust particles from the air. However, to clean these corrosive gases from the air they must be neutralized, and the only non-reversible way of doing that is by chemically reacting and binding them. Merely absorbing the gases is not sufficient because these systems can be reversed re-emitting the dangerous gases now in higher concentrations. Only Intercept reacts with and permanently neutralizes corrosive gases and act as a passive fungicide and bactericide.

Overview:

To understand how to protect items you have to begin to understand how these materials are damaged or destroyed. Protection of paper and paper products is a perfect fit for the Intercept Technology. Paper products are attacked and damaged by atmospheric corrosive gases and biological agents. This technical paper will review Intercept test data and compare the Intercept Technology to existing forms of protection.

Conservation:

As materials being preserved, as well as their packing materials age and deteriorate there are by-products given off; a natural occurrence of the organic material aging process. It has long been recognized that pollutants, such as ozone, Sulfur, Chlorine, and Nitrous gases can damage valuable collections. However, people assumed that the damaging gases and acids were confined to the outdoors or if they were inside that they were not at as high of levels. However these gases are produced indoors as well as outdoors, also the laws of chemistry prevail which state that environments reach equilibrium which ensures the gases outside find their way in.

These corrosive gases are produced indoors. Wood and Wood products (plywood, particle board, etc.) release formaldehyde, peroxides, acetic acid and formic acid. The basic paper process uses various chemicals as well as using sulfur as the main cross-linking agent (the binder to hold the paper fibers together). These paper products (including chipboard and paper corrugate) release Sulfur gases. Many glues and tapes are rubber based using Sulfur as the major cross-linking agent. These materials have excess Sulfur in their construction and, like paper, release Sulfur gases. Also just being in an industrial city or near an ocean environment will ensure high levels of Sulfur, Chlorine and Ozone.

Since collections are often housed together the concentrations of these corrosive gases can sometimes increase to significantly high levels. These gases pass easily through even the best packaging, to protect your artifacts the gases must be chemically and permanently reacted and neutralized.

Current Method:

One class of products on the market are barrier films - Aluminum barrier bags and Aclar film. These films work by acting as an active barrier to corrosive gases entering the bag and attacking the enclosed object within. The problem is that these bags are only as good as their seals, and only good as long as they remain completely intact. However, these bags were designed mainly to keep moisture out. Corrosive gases migrate quickly through most materials including through foil structures and other moisture barrier film structures. Testing at DuPont showed that Intercept Polyethylene film (PE) offered superior permeation prevention than Mylar (Polyester). It is important to note that Mylar and Aclar only work as barriers, and that they do not seal to themselves. These films have to be laminated to a Polyethylene (PE) film which acts as the sealing layer. The permeation at the seams is the same as the permeation through Polyethylene. With Intercept the material does not act as a barrier, but rather an active site for preferential corrosion. Intercept works even if not hermetically sealed - a claim no barrier film can dare make. Also, with a barrier or other non-Intercept plastic, the gases that the paper or the protected products evolve will be kept in close contact to the product, at high concentrations - only Intercept will react with these gases, cleansing the trapped air.

Another new product on the market uses molecular sieves and activated charcoal to absorb the corrosive gases. It is well known and documented that the absorption powers of activated charcoal can be reversed by increased temperature or humidity. Also, activated charcoal can contaminate stored products. Likewise, unless a chemical reaction occurs within a molecular sieve it to can, under certain conditions, act like a sponge being squeezed, releasing the stored corrosive gases. These materials also do not actively scavenge the air removing the corrosive gases, they merely "trap" and do not react with the gases. Without a reaction the gases are free to come out and also there is no strong driving force for the gases to go to the activated charcoal or molecular sieves. Gases, as like all chemicals, desire to react and become electrically or chemically neutral. It is this driving force that is not addressed with products that merely absorb, versus products that actively react with the gases.

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Current methods also do not address the issue of biological attack on the paper, paper products or photographic or transparency film. Bacteria and molds can adversely affect the paper products as well as plastic substrates. Even plastic Compact Discs have a shelf life because of bacterial attack. Likewise paper and paper products are adversely affected by this microbial activity. No product, on the market currently, for the preservation of paper or film adequately addresses this issue except for Intercept.

Intercept Advantage:

Intercept provides a safe and effective alternative to current preservation methods. Due to their relative size and high activity corrosive gases (including Sulfur and Chlorine gases) can easily penetrate even the most secure container. The only way to ensure that these corrosive gases are kept away from the paper or other objects being protected is by reacting and neutralizing the gases. Molecular sieves and charcoal papers merely absorb these gases. These absorbed gases can later be released. When the gases are released from the charcoal paper or sieves they are now at a higher concentration level, and more deadly.

Intercept does not work by absorbing these corrosive gases, Intercept reacts with them and permanently neutralizes them. One of the key ingredients in the Intercept Technology is that Copper is co-valently reacted into the polymer matrix. This Copper backbone gives Intercept its ability to react with and neutralize corrosive gases - both in the atmosphere as well as the gases trapped within the sealed or closed bag, box or tray.

As paper breaks down it liberates Sulfur gases. These gases need to be neutralized or they will turn around and attack the paper, further weakening it. With Intercept the material reacts with and neutralizes the Sulfur and acetic acid as they are released. Intercept also works equally as well and as effectively in acidic or basic environments - again key for paper protection.

Based on testing done at DuPont and Bell Labs it was determined that under normal levels of atmospheric Sulfur and Chlorine it takes over 10 years for Sulfur or Chlorine to break through .001" of Intercept film. As the gases attack the surface and try to permeate the bag the active Copper, attached to the polymer end chains, acts as a tortuous path for the gases. It is statistically improbable for any gas to migrate through the plastic without contacting an active corrosion site, reacting and being permanently neutralized.

DuPont Test Data Intercept Technology		
Material	PPM HRS (@640 ppm)	Simulated Exposure at Breakthrough (@ 1.0 ppm Cl)
LDPE	177 hrs	7.4 days
Mylar	132,480 hrs	15.1 years
Intercept LDPE	121,600 hrs	13.8 years
Intercept LDPE	302,720 hrs	34.6 years
Intercept Mylar	251,520 hrs	28.7 years

The testing done at DuPont was repeated on various samples to show repeatability - average values are stated above. It was determined that an average amount of Chlorine in most environments is approximately 1 ppm of Chlorine, which is why that value is reported.

Environment	Average Sulfur Gas Levels
Grassland	10 ppt to 100 ppt
Marshland	10 ppb to .1 ppb
Urban Indoor	.1 ppb to 10 ppb
Urban Outdoor	.01 ppb to 100 ppb
Industrial	10 ppb to 10 ppm
Manhole	1 ppm to 100 ppm

Likewise testing was done at AT&T Bell Labs to determine the permeation of Sulfur. Their results show that under a simulated exposure of 7 ppb of Sulfur (an average level of Sulfur gas in the atmosphere as a whole) that it took 10 years to consume .001 inch of Intercept film. The test results were verified by SEM analysis of the Sulfated Intercept film. This reactivity of the Copper that keeps the Sulfur from penetrating into the bag also cleanses the air trapped within any Intercept package. The high activity of the Intercept film makes it a preferential corrosion site versus any paper or metallic substance stored within. It should be noted that museums are considered to be urban indoor areas so the Sulfur level used is directly applicable to normal Sulfur levels.

Real time and accelerated outdoor aging studies have been set up and monitored over the past 8 years. No failures have been detected (no corrosion) on the Copper, Silver, Steel, or Silver alloys that have been protected using Intercept bags. Trials have also been done on paper products, however our results stress the metal test results since metals are a better indicator of the effects of corrosive gases than paper, which will show the effects of corrosive gases at a slower rate. The various trials show that Intercept is not harmful to paper and that the Intercept material will be effective at protecting even the most sensitive paper product.

Paper and paper products are also attacked by biological agents - mildew, mold, and bacteria. It is well known that Copper is a passive Bactericide Mildewcide and Fungicide. In the 1800's the government of France started using Copper Sulfate Tri-Basic or Bordeaux mixture as a replacement for the more expensive Verdigris to protect grapes from the ravages of mildew and mold. Copper interferes with the reproduction of these biological systems so within a relatively short time the inside of an Intercept container is free from mildew, fungus and bacteria. The most potent bacteria can only survive 7 days, without reproduction this strain will die off quickly within Intercept.

Case Studies:

We had a case with a major commercial wholesaler of jewelry. They sold Marcasite jewelry in Silver settings. Marcasite is a popular semi-precious crystal because it has a pretty metallic luster and can be faceted. Marcasite is also an unstable form

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of Iron Sulfide (FeS₂) which decomposes and releases Sulfur. They were having a major corrosion problem in their storage due to unknown forces - due in reality to the Sulfur being released from the Marcasite. The levels continued to build in storage quickly affecting articles nowhere near the Marcasite. Gases travel quickly. Nothing this customer tried worked, until they stored their jewelry in Intercept bags and totes, which eliminated the corrosion problems.

Another company, a major manufacturer of computer equipment, was having a hard time finding fully cured and dried wood pallets. The wood gave off high levels of Sulfur gases, formaldehyde, as well as acetic and formic acids. These gases and acids caused severe corrosion to every plotter shipped, as well as causing severe corrosion in the factory when the pallets were brought inside for loading. Intercept, with its ability to react and permanently neutralize corrosive gases was able to resolve the corrosion problems.

Conclusions:

Additional data is available upon request. The above information shows that Intercept provides protection from both corrosive gases as well as from microbial attack. Currently Intercept is in test at the National Geographic Society to protect their photographic negatives and prints. Intercept is an effective protection system that can replace traditional refrigeration storage.

Products Available and Uses:

To get the benefits of the Intercept Technology simply put your paper or paper products into an Intercept bag or container. Intercept even has built in saturation indicators that indicate when the product's useful life is over. The product changes color during its life and when a certain color is reached the bag or tote needs replacing.

Intercept is available in bag form: flat bags that can be easily heat sealed or taped closed, bags with a zipper fastener, moisture barrier bags with an Intercept inner layer. Intercept can also come in the form of tote boxes, plastic trays, and plastic corrugate (which can be made into boxes, trays, and other storage containers).

Intercept protects against Corrosion Damage:

- Reacts with and permanently neutralizes corrosive gases
- Works equally well in acidic and basic environments
- It is the only product available that is effective against Galvanic coupling (the corrosion that occurs when dissimilar metals are joined together)
- Leaves no detectable deposit on any product it protects (unlike VCI's)
- Does not coat - Intercept is completely free from volatile chemicals
- Cleanses trapped air of corrosive gases
- Intercept does not use any silicones or PVC
- Provides cost savings by eliminating secondary packaging or secondary cleaning operations often required with VCI protection or no protection
- Eliminates the need for storage in inert atmospheres or refrigeration
- Environmentally friendly with substantially reduced landfill time (breaking down into Polymer dust) and fully recyclable (meeting tough German recycling laws)
- Effective corrosion protection for the following materials:
- Silver
- Copper
- Bronze
- Brass
- Tin
- Ferrous Metals (Iron and Steel)
- Magnesium
- Wood
- Paper and Paper Products
- Photographic Film (Exposed & Unexposed)

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