

Corrosion myth # 25: Polymer coatings and polymer films are barriers that prevent your formula from causing valve, container or metal foil corrosion.

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In the Fall of 2008 I discussed container coatings, valve coatings and laminate coatings for spray packaging in a series of Corrosion Corner articles in the Spray Technology and Marketing Magazine. Several months ago I was asked to write a synopsis of these three articles for the Aerosol Form. This article is the synopsis for the September 2008 through November 2008 Corrosion Corner articles.

In the Pair O Docs® Elements of Aerosol Container Corrosion short-course we include discussion of the numerous myths about spray package corrosion. For fun we've assigned random numbers to these myths. Corrosion myth # 25 for valve, laminated foil and container coatings is: *Polymer coatings and polymer films are barriers that prevent your formula from causing valve, container or metal foil corrosion.*

Many of us have encountered numerous instances where container coatings and polymer films either delaminate from the metal, or allow formula water and formula ingredients to diffuse through the coating or film and corrode the metal underneath.

Polymer coatings and laminates on aerosol valves, traditional aerosol container coatings and the laminate coatings on the metal foils used for alternative aerosol containers

The polymer coatings and the polymer laminate films used for spray packaging are typically too thin to be barriers against corrosive formulas. In addition, the surfaces of the metals

used to fabricate valves, containers and laminated foils are often microscopically rough. For example, the aluminum used for containers and valves often has microscopic indentations, and the tin layer (coating) on tinned steel has numerous microscopic pores that expose either the base steel, or the discontinuous iron-tin alloy layer on the base steel (located between the tin layer and the base steel).

Figures 1 and 2 illustrate how the polymer could either bridge individual indentations or pores, or fill individual indentations on aluminum and pores in tin coatings (layers). Notice in the top illustration of both Figures that a void area is created under the polymer when it bridges an indentation or pore instead of filling it.

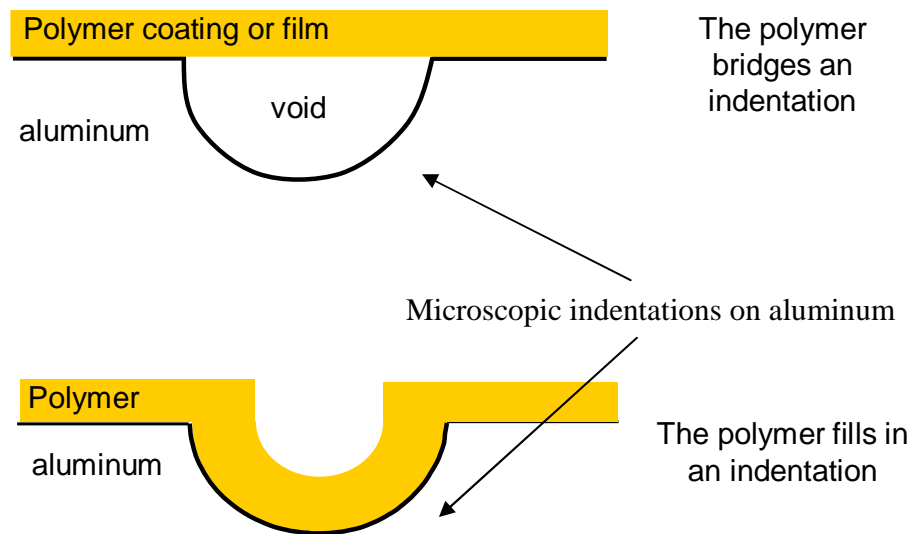


Figure 1. Polymers coatings on aluminum containers

There are many factors that determine if an indentation or pore will be bridged or filled by a polymer. Some of these factors are:

- The metal-polymer surface tension

- The size and depth of the pores or indentations
- Polymer viscosity during application to the metal
- Surface contamination of the metal during polymer application



A polymer coating bridges pores in a tin layer (coating)



A polymer coating fills pores in a tin layer (coating)

Figure 2. Polymer coatings on tinplates steel

Your formula chemistry and the polymer morphology (e.g., the degree of cross-linking) determine if the polymer bridging an individual indentation or pore will allow liquid to diffuse through the polymer coating into the void under the coating. Sometimes thin polymer layers become semi permeable membranes that allow only water and select formula ingredients to diffuse through the polymer instead of the entire formula. In other words, the interaction between your formula and the polymer or polymer-bridge determines the chemical composition of the liquid that diffuses through the polymer.

One would expect a void under polymer to be significantly more susceptible to corrosion than areas free of voids. However, you don't need voids to have polymer and metal corrosion. Liquid diffusing through a polymer in a void-free area could also cause metal corrosion.

The chemical composition of the liquid diffusing through polymers determines a) if metal corrosion will occur, b) if polymer corrosion will occur and c) if both metal and polymer corrosion will occur. In many instances the chemical composition of the liquid in a void or under the polymer is significantly different from your overall formula chemistry.

Basic types of coated valve, container and laminated foil corrosion

Figures 3 and 4 illustrate three basic types of corrosion 1) polymer blistering without metal corrosion, 2) polymer blistering with pitting corrosion and 3) anodic undermining of the metal under the polymer. The horizontal arrows illustrate the growth direction for blisters and anodic undermining. The vertical arrows illustrate the diffusion of liquid through the polymer, and the diffusion of metal ions (from corrosion) through the coating into your formula.

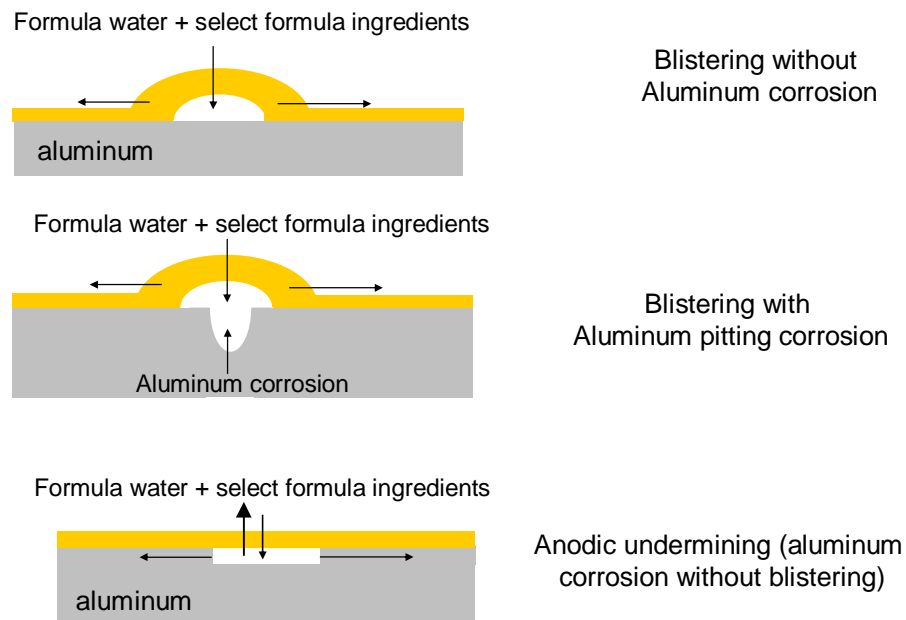
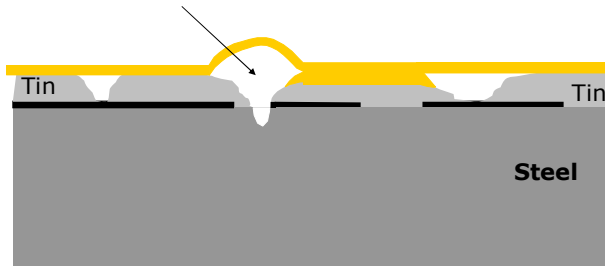


Figure 3. Three possible types of coated aluminum container corrosion

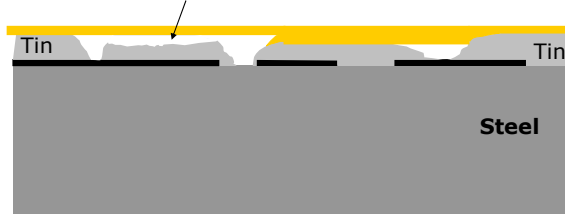


Polymer coating blistering with no container metal corrosion

Coating blister with steel pitting corrosion



Tin corrosion under the coating
(anodic undermining)



Tin corrosion only under the polymer coating

Figure 4. Three possible types of coated tinplate container corrosion

The top drawings in Figures 3 and 4 illustrate liquid diffusion through a polymer to cause coating delamination without metal corrosion. The delaminated areas (or blisters) in Figures 3 and 4 continue growing (spreading) along the metal surface as liquid continues to diffuse through the polymer. Figure 3 and 4 also illustrate that a pore or an indentation are not needed for blistering (delamination).

The middle drawings in Figures 3 and 4 illustrate pitting corrosion under a blister. Liquid diffusing through the polymer initially causes blistering; and subsequent liquid diffusion into the

blister initiates pitting corrosion. Liquid diffusion continues through the coating to propagate both the pitting corrosion and the blister growth. Liquid diffusion continues until the valve, container or laminated foil perforates.

The bottom drawings in Figures 3 and 4 illustrate how liquid diffusing through a polymer causes another form of coating delamination, referred to as anodic undermining. The liquid causes general metal corrosion instead of pitting corrosion. General corrosion removes metal from under the polymer but does not cause container, valve or laminated foil perforation. In my experience anodic undermining is very rare for aluminum containers and laminated foils, but it does occur in tinplated steel containers with internal coatings (liners).

In summary, polymer coatings and polymer laminates are usually not chemical barriers between your formula and the aerosol container. Container corrosion can occur in voids that form under polymer coatings. However, voids under polymer coatings are not necessary for container corrosion, and container corrosion is also possible under coatings where there are no voids.

There is no way to predict if a container will corrode with a given formula without corrosion test data. Consequently, corrosion testing is strongly recommended for all a) new formulas, b) line extensions of existing formulas, c) formulas with less costly ingredients, and d) alternate container suppliers.

Upcoming events at Pair O Docs® Professionals

Come see our new office and expanded laboratory at the Pair O Docs® Professionals open house at our Madison, Wisconsin facility on 19 May, 2009 from 3:00 pm to 6:00pm.

Please RSVP via our website at pairodocspro.com.

Our Elements of Aerosol Container Corrosion course will be taught again on 6 and 7 October, 2009 in Madison, Wisconsin. The course registration form and syllabus are available on our web site in the [courses](#)-section of our site.

Please also visit our website pairodocspro.com for more information about Pair O Docs® Professionals. Back issues of Corrosion Corner are available on CDs from the [Spray Technology and Marketing Magazine](#).