



*Customer information Obscured to insure privacy*

Re: Applicability of nickel underplate for gold plating stainless steel

Dear *Customer's engineer*,

This letter is to serve as a brief summary of my opinion on the applicability of applying a nickel underplate onto certain stainless steel alloys prior to the application of Type I or II, (as defined in specification MIL-G-45204C), electrodeposited gold. In the past 16 years I have been a party to many research & development and production projects where gold plating a variety of stainless steel alloys was indicated for a variety of reasons.

When working with the development or manufacturing engineers the question of a nickel underplate prior to gold plating usually was addressed. The determination of the use or deletion of a nickel underplate was based on the following considerations.

There are three normal purposes of a nickel underplate prior to gold plating;

1. Nickel is an economical, fairly effective diffusion barrier that will help prevent diffusion of reactive substrates such as cupreous or zinc alloys through the gold layer.
2. With the addition of organic contaminants nickel can be deposited with good leveling and brightening properties. This "Bright" nickel can reduce the cost of pre-plating polishing for decorative applications. It is important to note that the ductility of the nickel deposit is inversely proportional to the leveling and brightening characteristics of the bath.
3. As a pretreatment for steel alloys containing high chromium content a hydrochloric acid based nickel chloride solution is commonly used as a very cost effective method of activating the stainless steel. This solution is commonly known as "Wood's Nickel Strike". The extremely inert chromium oxide is reduced by the cathodic reaction of the hydrochloric acid and a very thin layer of nickel is simultaneously deposited to temporarily prevent re-oxidation of the chromium.

There are several reasons that nickel may be contradicted;

1. The addition of a nickel layer means that two additional metallic interfaces are added to the plated component. For electronic or electrochemical applications these additional interfaces can be detrimental to the properties of the plated component.
2. Nickel plate is a relatively reactive component that can diffuse through the gold. This is especially important for electrochemical or medical applications where nickel contamination is undesirable.
3. Nickel plating can bridge substrate preparation defects thereby creating hidden flaws in the plated component that may cause failure in use.
4. Nickel plate has relatively high stress and poor ductility that can result in cracking, peeling and flaking.
5. The addition of sufficient electrodeposited nickel plate to realize the benefits as stated in items #1 & 2 above, "purposes of nickel plating", may significantly alter the dimensions of the component. The use of less nickel thickness, (other than as a

pretreatment as in #3), provides all the disadvantages without any benefit and is therefore meaningless.

6. The addition of a nickel plating step significantly increases the risk of pretreatment and plating errors.

I believe that it is reasonable to weigh the contradictions against the advantages of applying a nickel underplate to stainless steel prior to gold plating.

1. Since a nickel plate is more reactive than most stainless steel alloys then Reason #1, nickel as a diffusion barriers, is meaningless, in fact the addition of nickel may actually increase the risk of diffusion through the gold and cause nickel contamination of the component environment.
2. Most technical applications don't require a decorative element so reason #2, enhanced visual appearance, is not important. Therefore the detrimental effect of deposit stress, poor ductility, dimensional alteration and additional metallic interfaces associated with a bright nickel plate make a nickel underplate undesirable.
3. The remaining reason for using a nickel underplate, as a pretreatment to ensure adhesion, is still valid. However, replacing the Wood's nickel strike with a hydrochloric acid based gold strike pretreatment will provide superior adhesion properties without the problems associated with nickel under the gold. The only disadvantage of using an acid gold strike instead of a nickel strike is the higher cost of the acid gold strike.

When I have worked with the electronic and electrochemical industry in development of stainless steel products utilizing a gold plated surface the decision has generally been made not to use a nickel underplate. The only time we have used a significant nickel underplate on stainless steel components has been when we gold plated certain stainless steel items where the texture of the finish needed to have a high polish such as some reflective components for the laser industry where a highly reflective surface was required and polishing the stainless steel was less cost effective than the application of a bright nickel plate. Please let me know if I can be of any further assistance.

Best regards,

Terry Darger  
Technical Director  
Gold Plating Services