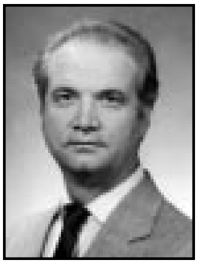

Advice & Counsel

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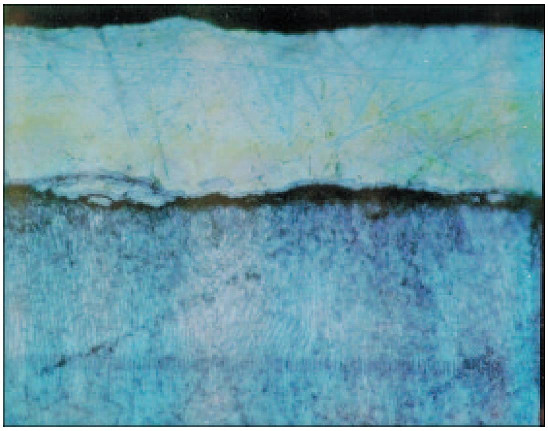
Training "Colombo"—Part IX
Acid Copper

Dear Advice & Counsel,
I have been following your "Training Columbo" series over the past months, waiting for advice on an acid copper solution. Ours seems to be quite troublesome. We plate mostly zinc diecastings, and the current density range is very dramatic because the parts we plate are casket trim diecastings. We periodically get blisters and are confused about how much chloride should be in our solution. One "expert" tells us it shouldn't be higher than 80 ppm; another says 100. Do you have an easy way to analyze for chloride? The latest problem is that the solution gives off a strong odor, making the eyes tear. My workers are threatening to walk out on me. Can you help?

Signed, Mr. Morbid

Dear Mr. Morbid,
Your odor problem was determined to be related to the operation of the solution at twice the recommended amount of sulfuric acid (along with the fact that you air-agitate and don't ventilate the tank). After reducing the acid concentration back to the normal range, your problem disappeared.

However, because you are having other periodic problems, we will cover the common copper plating solutions over the next few articles, beginning with acid copper.



Microscopic cross section, 400X, blistered nickel-silver electroplate over zinc diecasting caused by inadequate copper strike.

Purpose of Acid Copper Plating

Acid copper is plated in a number of applications to take advantage of this process' ability to deliver a highly leveled, bright surface over a wide range of current densities. Applications include the rotogravure industry, electroforming and plating onto castings. Your specific application—plating onto slush castings—utilizes acid copper:

1. To allow for "leveling" of the polished surface of the castings—Leveling is the ability of certain plating processes to fill in tiny scratches in the surface of a part. Acid copper is considered to be the plating solution that offers the highest degree of leveling ability.
2. For buildup of copper for further polishing/buffing, as necessary—Slush castings often contain small surface imperfections, such as surface and subsurface pits. When polished prior to plating, these pits tend to become more pronounced and will trap chemical solutions and later cause spotting of the final product. Some small pits and surface imperfections can be eliminated by plating a heavy thickness of acid copper, then buffing the surface, in an effort to smear the copper over the surface imperfections. This process of "saving" a casting that has imperfections is not always successful. It depends upon the size and location of the imperfections. There are other imperfections in castings, such as "cold shuts," which cannot be corrected or compensated for by acid copper plating.
3. To obtain a bright surface that requires little, if any, buffing and allows for the next plating processes, such as nickel and gold plating, to be fully bright.
4. For long-term protection against staining and corrosion by the

atmosphere (when over-plated with other metals, such as nickel and chromium)—An acid copper deposit is very fine-grained and pore-free. It will enhance the corrosion resistance of a part that is nickel and chromium plated.

Overview of Plating Process

Zinc castings cannot be directly plated in the acid copper plating solution. This is because the solution will chemically react with the surface of the casting, resulting in an ugly surface that might have loosely adherent copper on it.

The correct process sequence for plating these castings is:

1. Electroclean. The electrocleaner removes surface dirt.
2. Rinse. The rinse removes residual electrocleaner.
3. Dilute Acid Dip. The acid removes surface oxides and neutralizes the alkali remaining on the surface after electrocleaning.
4. Rinse. The rinse after acid removes traces of acid that remain on the parts.
5. Cyanide Copper Strike. The cyanide copper strike is a solution that does not chemically react with the casting, so it can be used to plate a very thin layer of copper over the casting. Rinsing is not necessary after cyanide copper strike, because the next step is cyanide copper plate.
6. Cyanide Copper Plate. The cyanide copper plate step builds up the thickness of copper to a point where enough of the casting is well covered in copper, so that there is no chemical attack of the casting when it is placed into the acid copper plating solution. If the copper thickness on the casting is too thin, blistering will result. The part you submitted had essentially no copper on the casting (less than 0.000005 in.).
7. Rinse. The rinse after cyanide copper plating removes cyanide from the surface so it can't react with the next step (acid dipping).
8. Sulfuric Acid Dip. The acid dip conditions the surface for the next step, which is acid copper plating.
9. Rinse. Parts should be rinsed before they go into the acid copper plating tank to remove excess acid, as well as to keep out impurities dragged out of the cyanide copper solution.

Acid Copper-Overview

The acid copper plating process consists of two basic ingredients and a tiny amount of hydrochloric acid, plus additives to obtain brightening and leveling. The process should deliver a bright, ductile, easily buffed copper deposit.

Making a New Solution

To make a new solution (150 gal in volume), follow these steps:

1. Fill a mixing tank (not the plating tank!) with 100 gal of water. Deionized water is preferred, but tap water can be used. The water should be tested by a laboratory for chloride content, so that the chloride can be adjusted to the

right ppm. For example, tap water in Chicago contains about 15 ppm of chloride, which should be compensated for when adding hydrochloric acid. Deionized water contains no chloride. If at all possible, heat the water to around 140° F. If this is not possible, it will take a lot longer to make up the plating solution.

2. Using a prop mixer to stir the water, add 260 lb of copper sulfate crystals ($CuSO_4 \cdot 5H_2O$). Stir until all the copper sulfate is dissolved.
3. Add 7 lb of activated carbon powder. Mix for one hr. Allow the carbon to settle for 2 hr.
4. Without disturbing the carbon that settled to the bottom of the tank, filter the plating solution into the plating tank or a second mixing tank. Be careful that none of the carbon is brought into the filtered tank. The last of the liquid at the bottom (containing all the carbon) will need to be disposed of.
5. Transfer the filtered solution to the plating tank, and run the filter continuously overnight with a high amount of tank agitation. The solution should be so clear that no carbon or any other solids are visible. A laboratory can filter through a glass fiber membrane to confirm that all the carbon has been removed.
6. The solution should be allowed to cool to room temperature. With a high amount of agitation, slowly add 6 gal of concentrated sulfuric acid to the plating tank. Sulfuric acid might violently react with the water if it is added too quickly, so be sure to wear all the protective equipment called for in the MSDS, and follow all safety precautions given in that document. Allow the solution to again cool down to room temperature (maximum of 95° F).
7. Adjust the chloride concentration by adding concentrated hydrochloric acid (15 mL to 150 gal equals 10 ppm of chloride). Assuming deionized water was used, you will need about 100 mL of hydrochloric acid. The safest way to do this is to add half the amount (50 mL) and have the solution analyzed. Then add the rest if the analysis shows you need more. If you add too much hydrochloric acid, it is nearly impossible to get it lowered. You will need to take some of the plating solution out and replace it with chloride-free plating solution. Therefore, it is best to proceed carefully and add less than you think is needed, because you can always add more later.
9. Add the brightener(s) and leveling agent(s).
10. Using parts that are not needed (dummies), plate for 15–20 min under normal conditions before using the solution on production parts.

Next month, we'll continue this discussion by addressing the function of ingredients used in acid copper plating, as well as the impurities encountered in such solutions. P&SF