## **Troubleshooting Decorative Chromium Baths**

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This paper will discuss common problems associated with decorative chromium plating baths and processes. It will focus on how to go about sectionalizing, localizing and isolating problems and how to resolve them once they can be correctly identified.

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Jeff Guernsey Electroplating Consultants International 12940 South 198th Ave. Broken Arrow, OK 74014 918-455-4411 FAX 918-455-0465 eciato@aol.com Trouble shooting decorative chromium plating systems can be difficult to say the least. A technician needs information to guide him in the correct direction i.e. nickel, chrome, related processes or equipment. Sectionalizing, localizing and isolating is a systematic approach to narrowing down problems and eliminating them. Plating systems are complex and each system is different from the next. The decisions about what defines a section and what defines a local area will vary from shop to shop but for the purposes of this paper sections and local areas will be defined as follows:



When discussing sectionalizing localizing and isolating decorative chromium systems a short discussion about eliminating the nickel solution as a possible section is needed. A good method for eliminating the nickel solution as a possible section is the HI-LO test<sub>1</sub>. The HI in the HI-LO test refers to a hull cell panel plated with a high current density nickel at 2 amps for 5 min using the hull cell configuration shown in fig.1 followed by conventional chromium hull cell plating of 5 amps for 3 min. The HI deposit contains a relatively low amount of organics and is therefore very receptive to chromium, in other words it is very difficult to plate a poor chromium deposit over a HI panel unless something is wrong with the chromium solution. The LO panel in the HI-LO test refers to a low current density nickel deposit, using the same hull cell configuration as before at 2 amps for two

minutes then reducing the current to 0.3 amps for 5 min. followed by conventional chromium hull cell plating of 5 amps for 3 min. The LCD nickel deposit contains a relatively high amount of organics and metallic impurities and is less receptive to chromium, given the higher amount of impurities. The results of the test can be used as follows:

Good HI panel/Good coverage – chromium solution is good Bad HI panel/Poor coverage – chromium solution is at fault Good LO panel/Good coverage – nickel solution is good Bad LO panel/Poor coverage – nickel solution is at fault

Successful interpretation of the HI - LO test will help the technician to determine if the <u>solutions</u> are at fault. Temperature control during the HI- LO test is paramount to achieving correct results from the test. An error as a result of poor temperature control can lead the technician in the wrong direction wasting several hours of precious production time.

A quick note on what constitutes good chromium plated hull cell panels. It's a bad time to start wondering what a good panel should look like when problems are occurring. The lab tech and or plating supervisor should have a running record of the kind of coverage their particular solution is capable of on a regular basis. Every shop plates different parts and has different requirements concerning chromium coverage. In some cases a panel showing 70mm of coverage will prove to be sufficient for production purposes in other cases 70mm of coverage could be detrimental. A new plating solution will have chromium coverage 75 to 82 mm on a 267 ml Hull Cell, a production bath may have slightly less. Run hull cells often and there will be no doubt as to what is good and what is bad!

Assume for example that the HI panel is bad, indicating a problem with the chromium solution. The local areas of the solution are the constituents and conditions that is, CrO3, SO4, catalyst & temperature. Isolation is a matter of analysis of the constituents, checking the temperature and restoring the balance. It is not enough though, to just restore the balance and be satisfied, the technician should ask why. Concerning the constituents, two common reasons that poor coverage may occur are climbing sulfate and decreasing catalyst. Some possible reasons for climbing sulfate are from drag out recovery, drag in of sulfate/poor rinsing prior to chromium plating or as an impurity in the water supply. Sure proof of drag in or of sulfate in the water supply can be seen with an addition of barium chloride solution to a sample of the suspect rinse water, a precipitate proves the presence of sulfate. I'm sure that most rinses just before the chromium solution will show some amount of precipitate, how much you can tolerate is up to you. Keep in mind if sulfate is present, nickel, chloride, boric acid and every other organic contained in the nickel solution may also be present.

Decreasing catalyst occurs for different reasons. The nature of the catalyst is to react with some of the impurities found in the chromium solution and become inactive. Impurities that render the catalyst inactive are Fe, Al, and boric acid. Eliminating the problem completely is difficult but can be minimized by reducing the sources of Fe and Al, start by raking the bottom of the tank and improving the rinsing.

If the analysis of the solution does not indicate an imbalance move on and look for impurities. Localization of impurities is a matter of finding which impurities are present. Isolation is a matter of finding out which impurity/impurities are the cause of the problem. Common impurities are metallics, trivalent, chloride and boric acid. The easiest way to identify and quantify any impurity in a chromium solution is obviously by analysis and much of the trouble caused by impurities could be eliminated if routine analysis were performed and the sources of the impurities identified and

minimized. Qualifying the total amount of impurities can be determined by Baume, that is, the difference in the concentration by Baume and the concentration by analysis gives an indication of total impurities. The impurities that have the greatest effect on the Baume are iron and trivalent, the chloride concentration would not affect the Baume reading and therefore some other method of checking for the presence of chloride is required.

The most common sources of metallics are from drag in and from the plated parts, probably at the bottom of the tank. Once metallics are in the solution they are difficult to remove although not impossible. Your best bet is to keep them from being introduced into the solution, easier said than done. Do the best you can. If the concentration of metallics is high enough<sub>2</sub> this may be the reason for poor coverage on the HI panel but, before the blame is placed on high metallics check for other impurities that can also cause poor coverage such as trivalent and chloride.

Trivalent chromium occurs naturally as a by product of plating however excesses of trivalent are caused most commonly by poor anode maintenance <sub>3</sub> or the attack of chromic acid on organic materials. The presence of trivalent is difficult to determine by means other than analysis although a change in the color of the solution from red to brown or a change in the Baume may be noticeable. A high plating voltage may also be noticeable as the presence of trivalent causes the resistance of the solution to be higher.

The presence of chloride can be determined qualitatively by the amount of etching that takes place on a <u>clean</u> brass panel that has been immersed in the solution for 10-15 seconds or by plating chromium directly over a brass panel in a hull cell, if chlorides are present the panel will be etched. It has been my experience that most solutions have some chloride present and will show some etching, what you don't want to see is heavy etching. Be aware that chloride is a catalyst similar to sulfate and is approximately eight times as strong, a ratio of 250:1 can be effectively changed to 150:1 with as little as0.075 g/l (0.01 oz/gal) of chloride. Now you have poor coverage!

Both trivalent and chloride can be eliminated by dummying the solution with a 10-20:1 anode to cathode ratio with air agitation. How long it takes depends on the amount of the impurities. Removal of metallics such as iron requires ion exchange or other types of equipment, check with your supplier for more information.

Boric acid comes from poor rinsing prior to chromium plating. As mentioned earlier it will render the catalyst inactive. Removal is by drag out and improved rinsing. Compensate for its presence and effects by adding catalyst cautiously.

Assume for the next example that the high panel is good indicating something other than the solution. The local areas would be equipment and related processes i.e. rinse tanks or process tanks between the nickel and chrome. To keep this short only a few of the most common equipment problems will be discussed. How do you localize between all the equipment and related processes? One approach would be to start with what is known. A high anode to cathode ratio is required to maintain a low concentration of trivalent, typically less than 2.25 g/l (0.3 oz/gal). If trivalent is not present as an impurity the anodes are in sufficient quantity and clean. Anodes should still be looked at out of solution as they can bend and cause problems or they can become light and lose contact on the anode bar. Once you are sure the anodes are in good shape take a look at the rectifiers, live lead and main. Does the live lead maintain contact all the way to the solution, is ripple present? Ripple can easily be check with a volt ohmmeter<sub>4</sub> less than 5% is acceptable. If ripple is not found, are the rectifiers set properly. Knowledge of the terminology true burn and false burn would be helpful at this point  $_5$ . Isolation of stray currents  $_4$  is time consuming and a shotgun approach is better than trying to find the needle in the haystack. Stray currents may sometimes be eliminated by changing the insulators found between the cathode and superstructure and the anode and super structure, it is much

more effective to change them all instead of trying to find the one at fault. Steam coils and heating coils should be fitted with plastic insulators etc. and a thorough visual inspection of any and all points around the machine that could possibly be a path for stray current entry into the solution. It is also recommended that a thorough cleaning of bus bar, bus bar connections, bus bar saddles etc. be done. You would be surprised at how much current can pass through a salted bus connection!

Many problems will show up on plated parts at specific places on the racks, on return type machines it could be on the leading edge or the trailing edge of the rack. Leading edge problems are almost always isolated to bi-polar or stray currents  $_4$  in the chromium plating tank. Trailing edge problems are almost always isolated to the related processes prior to the chrome (but after the nickel in this example because the assumption has been made that the nickel solution is good). The nickel rectifier should be looked at since ripple or a make andbreak contact at the exit station of the nickel can cause trailing edge problems. At this point it helps to be creative, turn racks to see if the problem moves, isolate racks from the cathode bar and look for changes, skip rinses etc. A hoist system may be more difficult to implement these types of tests but not impossible, remember, be creative.

Electrical connections are scattered throughout decorative chromium plating installations. Each point where a connection is made is a point for a potential problem. Each connection should be free of plating salts, oxidation and should be tightly connected. A poor connection may be warm/hot to the touch. Each connection has the opportunity to drop voltage across it causing the voltage measured at the rectifier to be greater than the voltage measured at the tank. Voltage drops across connections should be in the neighborhood of less than 30 mv. Electrical connections include those between rectifier and tank, anode bar to anode, cathode bar to cathode, etc.

Accuracy of the rectifier meters should also be checked. Compare the voltage read on the rectifier meter to the voltage at the rectifier output; the readings should be identical. The ammeter may be more difficult to check. It is connected across a shunt, which is nothing more than a resistor. The voltage drop across the shunt is proportional to the current output. Most shunts are rated at 50 mv, which means a measurement of 50 mv across it would indicate full output. The rectifier output current can be calculated as follows:

 $\frac{\text{mv reading across the shunt X shunt rating in amps}}{\text{Shunt rating in mv}} = \text{output}$ 

Many times the shunt is difficult to reach because of its location, in this the case since the shunt is wired to the back of the ammeter a my measurement across the back of the ammeter should be almost identical, given the distance between the ammeter and shunt, to the reading taken across the shunt.

## Conclusion

Trouble shooting chromium plating systems, or any plating system, can be challenging. Things get tough when more than one reason for a problem is occurring, by sectionalizing, localizing and isolating, each reason for a problem will be systematically eliminated.



Fig. 1 Hull Cell Configuration for HI-LO Test

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