The Hull Cell
For Decorative Electroplating

Back in the 1930's, I doubt Dr. Hull ever dreamed when applying for a patent for his test plating cell, that this unique tool would be the main service tool in the decorative plating industry in the year 2008. That most of the decorative addition agents in the world would be developed by the use of his Hull cell. The cell would also be the main service tool for controlling decorative plating processes, especially copper, nickel and chromium. With a little imagination one can custom shape panels to simulate almost any situation a plater may face. (A-1) These can vary from panels with shelves to pick up roughness and pitting, tight "V" shapes to plate very low current density areas checking for metallics, saw pattern sided panels checking for fine nodulations in high current densities, and perforated panels simulating low current density areas throughout the panel. Hull cells can stand in for a chemical analysis when an analysis is not available.

Nodulation Test Panel A-1 Electro-Purification Panel

Working with Hull cells break down into two categories, first, properly plating panels and secondly, properly interpreting panels. You will find very few photographs of plated panels showing the many conditions achieved, simply because it is virtually impossible to photograph a panel with its highly reflective surface. Hazes, clouds and speckling just do not photograph. Most information on panels rely on drawings to depict conditions. I have always recommended building a library of panels tuned to your operation. After plating your normal test panels, and before discarding the test solution, plate additional panels deliberately contaminating the solution with the possible contaminants in the line. This will allow you to display conditions for future reference and training. Since the plated surface is very active, and subject to oxidation, panel should be stored in Ziploc plastic bags.

Panel Amperage

Amperage	Current density range
1 ampere	0.5 - 40 amps per ft²
2 amperes	1.0 - 80 amps per ft²
3 amperes	1.5 - 120 amps per ft²
5 amperes	2.5 - 200 amps per ft²

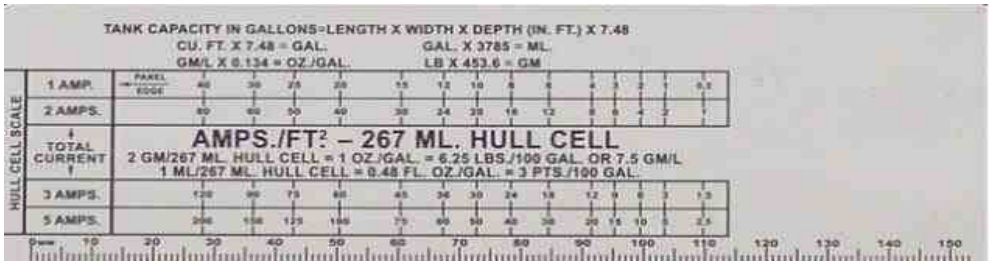
Equipment

Hull cells are available in two sizes, 267 mls. and 1,000 mls. In decorative plating the 267 mls. size is recommended. The 1,000 mls. cells are required in baths using very high current densities, such as acid copper plating on grounding rods, using current densities up to 600 asf. The larger volume is required to compensate for temperature increases and current carrying capacities. Hanging cells are also available; they extend down into the actual plating tank. I have never found use for these.

Hull Cell

The 267 milliliter cell was designed to plate a deposit on a steel or brass panel over a selected current density range. By placing the panel on a Hull cell rule you can observe the current density range you desire. Electro deposition is based on average current densities, when plating an average of 40 asf we may also observe what the deposit looks like at 2 amperes as well as 80 amperes. Since plating problems usually start in the low current density, and work up as well as the high current density and work down, we are able to see problems before they are in the current density range we are plating in, sort of a “Soothsayer” of plating conditions. A volume of 267 mls. was selected to simplify calculations. An addition of 2 grams to the cell equals 1.0 ounces per gallon in the bath. One milliliter in the cell equals 3 pints per 100 gallons in the bath. The advantage of the Hull cell is you can work by trial and error until the correct addition is established, consuming only a small volume of the bath. Brightener additions may be made this way, choosing the best results, adding that volume to a fresh bath. It is recommended that no more then three panels be plated per test.

Hull Cell Rule



The Hull cell rule allows you to view current density ranges for 1 to 5 ampere panels. It also contains formulas to calculate additions, as well as a millimeter rule to measure chromium coverage.

Hull Cells Are Available For Different Applications

1. Standard non-heated, non-air agitated Lucite, recommended for cyanide zinc and cadmium solutions.

2. Hi-density polyethylene, recommended for chromium solutions

3. Non-heated air agitated for baths requiring agitation, recommended for acid copper and chloride zinc.

4. Heated, an air agitated, recommended for semi-bright and bright nickel solutions.

Power Supplies

Rectifiers should have a DC output of at least 10 amperes @ 12 volts, with maximum ripple of 5%. Multiple Hull cells may be processed with one rectifier, by connecting the cells in series

Agitation

Cell may be air agitated with a standard aquarium air supply with needle valve control. Paddle agitation is available for non air baths such as cyanide copper.

Panels

Panels are available in both brass and steel. Brass panels have a strippable coating that is peeled off prior to cleaning. This coating is easily removed on new panels, as panel's age this film becomes quite difficult to remove. Maintain a supply of fresh panels. Panels are lustrous with very fine vertical polishing lines. Examine panels prior to use to be sure there are no surface imperfections or pitting. Steel panels have a thin electroplated zinc deposit which is stripped in hydrochloric acid prior to use. Care must be taken that a clean acid is used, as zinc builds up, panels will develop a smut that must be physically removed. I prefer brass panels over steel for nickel. Polished brass mirrors back the nickel deposit.

Cleaning Of Panels

Producing a good panel requires good cleaning. Panels should be cathodicly cleaned. This is accomplished in a 2,000 ml stainless steel beaker. A hot plate sized to maintain a temperature of 180 F. is recommended

1. Cathodicly clean 2 minutes at 5 to 8 amperes.
2. Cold water rinse.
3. Acid dip 10% Hydrochloric acid.
4. Cold water rinse

Panels should be placed immediately in cell and plated.

Additive Additions

Recommended concentration of many additives may be as small as 0.1%. It is difficult to pipette an addition that small. Diluting additives to 10% allows you to make a 1 ml add which is more precise.

Standard Panel Bright Nickel Panel

A standard panel for bright nickel is plated for 10 minutes with moderate air agitation at 2 amperes. Panel should be bright over complete range, exhibit good leveling, with a slight swirl in the low current density area. Panel should be free of speckling, have good ductility and adequate coverage on back. Leveling is determined by degree visible polishing lines. In a well balanced bath virtually no lines will be visible except for the last 3/16" of panel. When panel is bent 180° cracking should not be heard.

Common Nickel Problems

1. Dullness
2. Roughness
3. Pitting
4. Ductility
5. Metallic Impurities

1. Dullness – Usually due to low secondary brightener.
   Panel lacks overall brightness, especially in low current densities. Panel polishing lines are visible. Panel may also display bluish cloud.

   Correction – Make a 10% solution of secondary additive. Add 1 ml until a bright deposit is achieved**.**

2. Roughness – May not be apparent on vertical surface of panel. Cut and form a shelf panel. This will display particulate matter.

   Correction – Filter solution through Buchner Funnel and Whatman #42 filter paper. Rerun panel.

3. Stardust – Caused by micron size particles from breakdown products.

   Correction – Have a volume large enough to produce two samples. Plate a 30 minute 2 ampere panel, if star dusting is visible; to the second sample add 1 ml of a dispersant wetting agent. Plate a panel, if free of all star dusting, make an equivalent addition to bath.

4. Pitting – Caused by organic contamination.

   Correction – Add 0.2% of wetting agent. Run second panel. If pitting is still present, filter solution through Buchner Funnel with #42 Whatmen filter paper coated with activated carbon. Run and inspect panel.

5. Metallic impurities – Metallic contaminants start as black bands in the low current density areas. Zinc will appear as zebra stripes.

Correction – Form a "V" shape panel that fits into LCD area of the cell. Plate 0.2 amperes for 10 minutes, examine panel. A time sequence may be calculated using this panel to determine the time of electro-purification needed to remove metallics.

Decorative Hexavalent Chromium - Fluoride/Sulfate Bath

Chromium baths may be totally controlled with a Hull cell with a little practice and learning how to interpret the panels. Care must be taken on handling the electrical contacts; any loss of current will cause a white wash pattern, leaving you to wonder if the problem is chemical or poor contact. Chromium should be plated over a freshly plated nickel panel, preferably over the nickel being used in the plating line. I prefer to nickel plate my panel, rinse well and place it in the cell, make electrical contact, then pour the chromium into the cell at 1 ampere, gradually increasing current to 5 amperes for 2 minutes. This procedure simulates the automatic programming used on most automatic plating machines. Coverage will vary from 60 to 85 millimeters for the average bath. Our goal is to extend the coverage as much as possible. The deposit should be free of white wash and rainbow staining. The normal panel is rinsed and wiped dry. To check for staining the panel may be air dried.

Common Chromium Problems

1. High current density burn – Low Sulfate, high ratio.

Correction - Add Sulfuric Acid

2. Poor coverage – High Sulfate, low ratio.

Correction – Add Barium Carbonate

3. White wash – Low Fluoride

Correction – Add Fluoride catalyst

4. Rainbow stain – Low fluoride

Correction – Add Fluoride catalyst

5. High Current density halo – High Fluoride

Correction – Add Boric Acid

Acid Copper

Acid copper panels are quite representative of the plating bath, additions to the cell reflect the results to the work in the bath. An air agitated cell is used with vigorous agitation. Panels from a bath in balance are bright from high to low current density. Acid copper baths level well, this is demonstrated on the polished brass panel. Panels are plated at 2 amperes for 10 minutes.

Common Problems

1. Low Copper Sulfate – High current density burn.

   Correction – Adjust chemistry.

2. Low Sulfuric Acid – High current density burn.

   Correction – Adjust chemistry.

3. Low Carrier Additive – Cloudy high to mid current density – Nodulations on edge of panel.

   Correction – Add 1.0 ml of Carrier Additive.

4. Low Secondary Additive – Dull low current density.

   Correction – Add 0.2% of Secondary Additive

5. High Secondary Additive – Worm tracks throughout panel.

   Correction - Filter bath through Activated Carbon.

6. High Carrier Additive. – Cloudy deposit with low current density skip.

   Correction – Filter bath through Activated Carbon.

Electrolyte	Cell	Agitation	Temperature	Amperage	Time	Panel
Bright Ni - R	L	A	145° F	2	10	Brass
Bright Ni - B	L	A	145° F	1	5	Brass
Microporous Ni	L	A	145 ° F	1	3	Brass
Semi-bright Ni	L	A	145 °F	2	10	Brass
Acid Copper	L	A	75 °F	2	10	Brass
Chromium	HPE	No	110 °F	5	2	Ni/Brass
Cyanide Copper	L	Mech	160 °F	5	5	Brass

L- Lucite HPE – High Density Polyethylene

Summary

The Hull Cell is a very diverse tool with unlimited possibilities in the control of electroplating baths. Use your imagination in designing panels to exhibit particular plating problems. Assemble a library of panels for future reference and training. We have discussed decorative applications only. The Hull cell will help you solve problems in any electrolyte that will deposit metal. As long as there is plating, there will be Hull cells.

