

Improve Your Metal Finishing & Plating Results with Tips from our Tech Team

Environmental regulations, corrosion requirements, meeting specific designations and specifications, increased quality production and the demands of various industry users. As a result, it takes a team effort to do our jobs better, safer and faster. It takes trouble shooting. Understanding processes. Knowing how to adapt. What to use - and what not to. The following items have been drawn from Hubbard-Hall's collective experience as "news you can use" – to help us all meet and exceed expectations.

1. Duplex Nickel: Serious Corrosion Fighter

Duplex nickel is most effective in achieving the optimum corrosion protection of nickel-plated parts with a flash of chrome (think automotive applications). The typical dual nickel deposit – a 75% underlayer of semi-bright nickel followed by a 25% topcoat of bright nickel – provides excellent corrosion protection. In fact, controlled corrosion testing confirmed that corrosion on copper/bright nickel/chromium-plated zinc die-cast parts occurred within 12-18 months in severe testing environments. By substituting an equal thickness of duplex nickel, corrosion was delayed for at least 24 months. Also, noteworthy: the ductility of the semi-bright deposit is at least 500% greater than that of the bright deposit. Details for the application and control of duplex nickel followed by a flash chrome topcoat are precisely defined per ASTM B 456.

Total nickel deposit thickness should be a minimum of 0.0005 inches (0.5 mils). The semi-bright nickel deposit must equal or exceed 60% of the total nickel thickness. The sulfur content of the semi-bright nickel must not exceed 0.0005% by weight.

The bright nickel deposit thickness should be less than or equal to 40% of the total nickel deposit thickness. The sulfur content of the bright nickel deposit should exceed 0.03% by weight.

Microporosity of the chrome deposit should be 64,000 pores/inch².
Duplex nickel deposits are very prevalent in exterior automotive finishes.

Visual examples:

Diesel Truck



Aluminum Wheel*Motorcycle*

2. Trivalent Chromium Plating: Healthier, Safer, Twice as Efficient

This process employs inert anodes, inorganic trivalent chromium salts, conductivity salts, complexing agents, wetting agents, and grain refiners. The plating solutions are typically blue to blue green in color, depending on the proprietary bath commercially used.

Bonus: The health and safety hazards associated with hexavalent chromium baths are eliminated. (All hexavalent chromium compounds are bad actors and considered carcinogenic to workers. The risk of developing lung, nasal, and sinus cancer increases with the amount of hexavalent chromium inhaled and the length of time the worker is exposed. Studies of workers in chromate production, chromate pigment, and chrome electroplating industries employed before the 1980s show increased rates of lung cancer mortality. Certain hexavalent chromium compounds produced lung cancer in animals that had the compounds placed directly in their lungs.)

*Hexavalent Chromium Based Plating bath*

The introduction of commercial, decorative trivalent chromium plating has been a major benefit to the plating industry and to meeting health and safety regulations.



Decorative Trivalent Chromium Plating Bath

The aesthetic differences in photos like those above, comparing the plating baths, seem to bear stark witness to the far more benign trivalent chromium bath.

The reduction of trivalent chromium to the metallic state requires three electrons, versus the same reaction that requires six electrons for the hexavalent chromium ion. Therefore, the trivalent chromium bath is at least twice as efficient as the hexavalent bath (approximately 30% compared to approximately 10%).

The rectification demand is likewise reduced. Trivalent chromium baths tolerate 5% AC current ripple (similar to nickel). Current interruption does not result in the plated deposit whitewash in hexavalent-based baths.

Two types of decorative trivalent chrome baths are in commercial use. One uses carbon anodes in a chloride-based electrolyte. The other uses an alloy of the platinum group of elements on an inert core in a sulfate-based electrolyte. Both types of baths require a source of Chromium III inorganic salts, a grain refiner, buffer, and wetting agent.

Trivalent baths support larger surface areas per flight bar (more parts) for decorative plating applications, giving greater production throughput. In some production installations, the limiting factor to parts loading on flight bars is a factor of the preceding nickel-plating bath.

Trivalent chromium deposits are typically slightly darker than hexavalent deposits. This is due to the incorporation of organic agents into the deposit, which modify the crystal structure.



Decorative Trivalent Chrome Plated Parts

Note: Trivalent chrome baths deposit the metal to a limiting thickness, of approximately up to 20 millionths of an inch. There is a point in the deposition process where the thickness becomes self-limiting unlike the hexavalent bath, which will keep building in thickness. This is a driving force in improving chrome deposit thickness (>0.001”) to replace hard chrome, a drive that is gaining momentum.



Commercial Hard Chrome from a Trivalent Based Electrolyte

Another challenging project has been developing a production barrel decorative trivalent chromium plating process. As mentioned, the driving force is tolerant to current interruption.

Similarly, trivalent solutions will not passivate unplated steel surfaces (such as the inside of tubes). Therefore, chrome-free passivating post dips may be required.

Since the PEL (Permissible Exposure Limit) for hexavalent chromium and all other hexavalent chromium compounds is five micrograms per cubic meter of air as an eight-hour time-weighted average, decorative trivalent chromium baths should gain practical consideration.

Additionally, trivalent chromium deposits meet the ELV directive and comply with RoHS.



In comparison to hexavalent chromium, decorative trivalent chromium electrolytes gas much less – and, significantly, that gas is non-hazardous and non-toxic. They are twice as efficient, exhibiting 25-30% efficiency vs. 10-15%. Also, the wetting agent provides a thin foam blanket, eliminating at least 99% of mists

3. Nasty Oils: Getting Them Out

Certain oils can be exceedingly difficult to remove in the soak cleaner, especially if they adversely affect the finishing cycle. Chlorinated and paraffin oils can literally gum up on parts especially when using caustic (sodium or potassium hydroxide) cleaners. Better cleaning results can be obtained with non-caustic, alkaline cleaners that are silicate-based, containing specific ratios of nonionic to anionic surfactants.

Molybdenum-sulfide lubricating grease can also be a tough material to clean off. The soak cleaner type described above may also work best here.

Mineral, spindle and water-soluble oils may best be removed in a soak cleaner that contains approximately 25% caustic and silicates, in addition to the aforementioned surfactants, with additional dispersing agents. Post-cleaning observations and appropriate testing should lend sufficient decision support to your ultimate choice of soak cleaner.

4. Rust Spots in Electrocleaning

How often have you noticed steel parts exiting the electro cleaner with a brown, stained appearance? Or worse yet, brown splotches and even high-current density burning? It happens in rack and barrel. Chances are that it's the wrong electrocleaner formulation, or maybe the right one—under-concentrated. Lack of reserve alkalinity in the bath will not be able to dissolve the iron hydroxide film that forms on the surface, during anodic conditioning. This reserve alkalinity is referred to as caustic soda. Even less caustic results in poor conductivity that tends to etch and burn the high-current density. Adjust the operating electrocleaner concentration, or switch to an appropriate concentrate blend.



Corrosion Spots after Electrocleaning

Another challenge that occurs in rack and barrel systems: Parts exiting the bath are found to have black spots on them – corrosion spots. This problem is typically found in double-cleaning cycles, or where racks or barrels cross over between the acid and electrocleaner. Drag-in of the first hydrochloric acid solution into the second electrocleaner introduces chloride as a contaminant. During anodic treatment, chloride is attracted to the part, forming chlorine gas bubbles (oxidation product). The bubbles remain in place long enough to etch the steel.

Corrective measures include switching the acid from hydrochloric to a suitable alternative, such as sulfuric acid; better rinsing between the acid and electrocleaner; or switching to a sufficiently inhibited electrocleaner formulation to prevent corrosive etching on steel.

What about Aluminum?

See the source image. We associate this metal with its superior strength - similar to steel but roughly half its weight. Yet it is still soft and pliable. The following tables describe aluminum and designations of aluminum alloys and their typical industrial applications.

The first digit is the principle aluminum alloy.		
The first digit also describes the aluminum series. Ksi is ultimate tensile strength range.		
1XXX	Min 99% Aluminum	10 - 27 ksi
2XXX	Copper	27 - 62 ksi
3XXX	Manganese	16 - 41 ksi
4XXX	Silicon	25 - 55 ksi
5XXX	Magnesium	18 - 51 ksi
6XXX	Magnesium and Silicon	18 - 58 ksi
7XXX	Zinc	32 - 88 ksi
8XXX	Other Elements	

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ALLOY SERIES	ALLOY	PROPERTIES	APPLICATIONS
1XXX	Pure	Low strength, excellent thermal/ electrical conduction and corrosion resistance, highly reflective	Fuel filters, electrical conductors, radiator tubing, lighting reflectors, decorative components
2XXX	Cu	High strength, relatively low corrosion resistance, good elevated temperature strength	Aircraft skin, aircraft fittings and wheels, ballistic armor, forged and machined components
3XXX	Mn	Medium strength, good formability, good corrosion resistance	Storage tanks, beverage cans, home appliances, heat exchangers, pressure vessels, siding, gutters
4XXX	Si	High castability, high machinability, high fluidity, low ductility	Variety of castings, including large castings, filler metal (2xxx, 3xxx, 5xxx and 7xxx used for castings)
5XXX	Mg	Medium strength, good formability, excellent marine corrosion resistance	Interior automotive, appliance trim, pressure vessels, armor plate, marine and cryogenic components
6XXX	Mg, Si	Med-high strength, good corrosion resistance, easily extruded	Exterior automotive, automotive profiles, railcars, piping, marine, screw stock, doors and windows
7XXX	Zn	Very high strength, prone to stress corrosion, poor corrosion resistance	Aircraft construction, truck trailers, railcars, armor plate, ski poles, tennis rackets
8XXX	Li	Very high strength, low density	Aircraft and aerospace structures, foil, heat exchanger fin stock

As we all know, raw aluminum is alloyed with metals such as magnesium and silicon. The product is then baked, transforming the alloy into a strong, durable material. However, until recently, it was not understood how the alloy structure forms and promotes high strength.

First, the element silicon forms a pillar and skeleton assembly. In this assembly, particles of an inorganic complex are formed consisting of magnesium, silicon, and aluminum. This critical structure then forms an additional inorganic species made of magnesium/silicon. This formation inhibits the tendency for aluminum to behave as a smooth metal. Now that this heating and annealing process is more understood, even stronger and more workable aluminum alloys may be formed.

Our People. Your Problem Solvers.

For more information on this process,
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