Design Engineering

Steve Koelzer
Vice President, Research & Development
K & K Products & Consulting
709 W. Remington Drive
Sunnyvale, CA 94087
E-mail: smbk@slip.net

Cleaning & Pretreatment & How They Concern Design Engineers

The focus this month is cleaning and pretreatment. The following will entertain that portion of this subject that is of particular concern to design engineers. Others who read this column should benefit as well.

The principal idea behind cleaning before plating or finishing is to prepare for subsequent adhesion. The finish may receive another layer, such as paint or Teflon®, and will still benefit from a particular microstructured surface, cleaned for adherence of the applied coating. The microrough surface sturcture may be obtained by etching, as in the case of "inhibited" acids or pickles, or if the material is not of the right grain size and relatively impervious to physical or chemical treatment, such as with hardened steel, an inorganic crystalline surface can be grown. Such surfaces (Parkerizing at 200 °F in zinc manganese phosphate baths) are used for holding oil during "break-in" of camshafts, molysulfide onto pistons for friction reduction by electrocoating of solids from solution, and trisodium phosphate (TSP), which degreases as well as leaves sodium phosphate surface crystals for binding paint.

An adherent but evanescent coating is zincating. It protects aluminum surfaces from oxidation until the coating dissolves and/or codeposits during plating. Most cleaning is for hydrocarbon, burr and debris removal.

A previous "Design Engineering" column (May 1998, p. 91) dealt with adhesion. The adhesion working range is the work of separation *plus* the interface restructuring work. The restructuring work of the interface is influenced by many adsorbates (sulfate, chloride, benzotriazole, oxygen, nitrogen, etc.). Therefore, cleaning and rinsing conditions become *very* important for adhesion bond strength. This also applies to the constituents in the plating bath.

Bond strength is also affected by surface oxide reduction (application of initial high current) or "striking," which also initiates many growth centers. Brush plating owes its success to both close anode and cathode proximity (more efficient current conduction, so less bulk solution resistance) and high nucleation rates for growth, also from the use of pulsed rectification (equal times, on and off), where each "time on" renucleates growth centers.

Other methods of increasing adhesion include anodically removing basis material for a short time before going forward cathodically, using an ammonia-containing solution to reduce oxidation and tie up hard metals (such as calcium), laser cleaning of surface volatiles, plasma etching, etc. Just because a surface is clean, doesn't mean plating will adhere.

Carbon steel is a common engineering material. Unfortunately, if over-etched in hydrochloric, a surface rich in graphite becomes exposed. This happens when cleaners aren't perfectly maintained, or the brand of anti-oxidant used in the machining oil or protective coating formulation contaminates the cleaning bath. Concern for human health originally got us into this "pickle."

The best cleaner for carbon steel was perchloroethylene, creosote and ortho-dichlorobenzene. The best alternatives were addressed in *P&SF*'s "Branch News" (July 1997, p. 79) from the Santa Clara Valley Branch.

Platers like to have some of their cleaning woes alleviated by the design engineers. So here's what you can do from the field of metallurgy for "green" design engineering. Consider your sources of material, their quality of composition and heat treatment. "Contamination" introduced for ease of machining (*e.g.*, lead, phosphorus, sulfur, etc.) might be reconsidered. To ensure the best paradigm for cooling, quenching chemistry, subsurface scale often has to be removed from alloy. Poor annealing will enrich surface composition compared to cores of bulk material. Specify compatible machining coolant-lubricants and pickles (protective coatings used for storage).

Specify alloys that will better retain tempers; don't allow the least expensive raw material type or source of material to enter the picture, and maintain a quality of engineering standard for manufacture. P&SF