Plating at Home

The Nuts and Bolts of DIY Plating

By Bruce Smith

There are a few decisions to make when restoring your car's hardware. You could try to get as close to original as possible with careful research of the materials and methods used by the factory. But the problem with doing this for parts from an old Porsche is the variety of suppliers used and variations each may have had with protective coatings. Add to that the sacrificial nature of plated parts after 50+ years exposed to the elements and you might have little evidence of original composition. Sometimes the approaches used to restore coatings will involve personal taste. This was no better demonstrated than on the infamous MaestroMassaged motors with yellow cadmium and noble metal plating on brackets, straps, bolts, nuts and the dip stick. But the Maestro himself noted that the yellow luster of Type II cadmium was short lived once oxidation set in. As for the actual gold plating on the few storied Super 90s, these coatings should have survived this long (if prepped well) – but do we have any evidence after 30 years?

So the first thing to decide once you've looked over your parts is what you'd like to achieve. The choices come down to simply cleaning them, re-plating them, or celebrating their patina (AKA rust). A thin rust layer isn't such a bad thing in a dry environment. But rust is porous and will absorb moisture, allowing the oxidation to continue beneath. If your car is kept in the garage, a little rust on the hardware may not need more a fine steel wire wheel or brass brush. There is often more of the original plating remaining than you'd expect. If re-plating is the chosen route, it's easy enough to throw the parts into a to-be-plated bin. The hard part is deciding on the next steps. If you're so inclined, there can be advantages to DIY plating – no lost parts, small batch runs, and possible cost savings. These upsides can easily be undermined by the potential downsides – coating quality, time involvement and the upfront costs of equipment and supplies. If you're willing to spend a few hundred dollars and the time to get things going, you can produce results even better than what you might get from your local plater. And this will be close enough to original under most any scrutiny.

Some Background on Porsche "Factory Coatings"

There is controversy in most all things 356 and opinions can vary regarding the original protection for parts and hardware. This is understandable as factory documentation can be open to interpretation. Since Porsche outsourced most things, there is also a likelihood that the coatings vary on otherwise similar parts. For steel hardware, the Porsche nine digit numbering convention called out either 'galvanic protective coating' using a part suffix code 02 (the zero meaning steel), 'phosphating/Bostik and Endurion treatment' using a suffix 01, or 'without corrosion protection' using a suffix 00. For example, a steel cylinder head nut washer (999.031.062.02) has a galvanic coating while a 6mm spring steel washer (900.028.008.01) is phosphate coated. Documentation for the coatings on parts for carburetors, distributors, fuel pumps, generators, etc. is less detailed though the choice of would have been similar. So what follows is brief description of these various coating types.

Galvanic Protective Coatings

A galvanized coating can protect steel from rusting through a sacrificial cathodic reaction, while creating an outer surface more impervious to the environment. For a metal to be galvanizing, it must have higher electropotential compared to steel. Useful metals in order are magnesium (highest and furthest from steel) followed by zinc, aluminum and cadmium. Other properties are also important like hardness, adhesion, malleability, heat resistance, surface finish, cost, and the influence on clamping force (the ability of a fastener to hold). Cadmium and zinc are generally better than others in these regards. Much of the torque applied to a fastener is lost to the friction of surfaces and threads. Plating a fastener with the right metal can reduce its torque coefficient by up to 25%, requiring less applied torque for a desired clamping load. Surface rust has the opposite effect, driving the torque coefficient higher. The use of cadmium or zinc plating improves the lubricity of a part and is a necessary element in achieving adequate clamping force. Cadmium can tolerate high temperature loads, near its melting point in excess of 320°C (600°F) while zinc galvanizing will begin to degrade above 200°C (390°F). With a less voluminous oxidation byproduct compared to zinc, cadmium has been preferred in many applications including military, aerospace, and automotive hardware.

Both zinc and cadmium have a bright clear finish in their "as plated" state. Untreated clear cadmium is referred to as Type I plating. Supplementary treatment with chromate compounds can provide improved corrosion protection in colors including yellow, bronze, brown, olive, and black. This is known as Type II cadmium. There's little dispute that Type I cadmium was used to plate parts in a 356. Yellow Type II was used by Porsche starting in the late 1960s with 912/911 cars. You may find an exception but I believe even the single shaft Solex SC carbs follow this convention, changing over to yellow Type II sometime around the split-shaft introduction for the 912. Plated thicknesses were probably somewhere from 5 to 25 microns (0.0002 to 0.001"), which is still common. But this can't really be confirmed by measuring things now.

There is a big downside to using cadmium and its compounds – they are highly toxic. Cadmium is a carcinogen that targets nearly all parts of your body (or the body of the guy doing the plating) and has been phased out since the 1970s. Zinc, on the other hand is an essential part of your health and wellbeing. Being the runner up to many of cadmiums attributes (and with better galvanic protection) zinc is the logical replacement. Both plating and removal operations are fairly safe. As a replacement, and especially under the conditions we now subject our cars to, the differences between zinc and cadmium are likely imperceptible. In fact, not all galvanized parts in old Porsches were cadmium – some were originally plated with zinc.

In the March/April 1994 issue of *356 Registry* magazine, Dave Grant reported his results from analyzing a few 356 parts that had original coatings. Among them were the generator pulley and the pulley bolt, like the ones I've pictured below (which I believe also to be original). Dave confirmed that the pulley and several other parts were cadmium plated but the pulley bolt was not – it was zinc plated. He also found the engine oil plug to be coated with zinc. This doesn't mean that all 1600 pulley bolts and oil plugs were plated as such - and it's impossible now to know for sure. And something else interesting —if you examine the pulley assembly below (or if you've had yours apart)—you'll see that between it and the bolt is a spring washer. Dave apparently didn't test one but I'm betting that his wasn't electroplated with either zinc or cadmium. This is because electroplating processes generate hydrogen, which will diffuse into a material to interfere with the crystal slip necessary for metal deflection. This is known as hydrogen embrittlement and spring steel with a high carbon content is especially susceptible. Springs, spring washers, spring clips, and the like need to be stress relieved before plating and heat treated again immediately after plating – a process that must be done right. An alternative is to use a non-electroplating process and avoid the possibility of embrittlement. That brings us to the next treatment type – phosphating.

A generator pulley, spring washer and pulley bolt with unique protective coatings. The difference in appearance between the bolt and pulley are from roughness of the underlying parts.

Phosphate Coatings

Phosphate conversion is carried out on the surfaces of steel or iron in a high temperature phosphoric acid solution with salts of zinc, iron or manganese. This isn't a 'plating' (making the title of this article a bit of a misnomer) but instead a chemical conversion treatment. A metal phosphate protective coating is formed which will also reduce the friction between moving parts. These treatments can be a base for paint or powder coating but are also used alone if followed up with oil or some other sealer. Iron phosphate is porous and is only protective when treated with oil (sometimes referred to a phosphate and oil coating). As far as the Bostik Endurion treatment called out by Porsche, the May 1959 issue of *The New Scientist* magazine described this as a chemical alternative to oil to increase the protection of steel parts. The terms Parkerizing and phosphating are often interchanged, though Parkerizing usually includes nitrates, chlorates, and copper to affect the color and appearance of a coating. Black oxide coatings are something different and merely an iron oxide (Fe_3O_4) layer formed by chemically dipping a part into a hot sodium hydroxide solution. This does little more than enhance the appearance of carbon steel and the oil film over top is the only real protection.

Bosch distributor clips, an example of items with a phosphated finish

Since phosphating treatments are chemically formed and not electroplated, hydrogen embrittlement is not an issue. Phosphate coatings can withstand moderately high temperatures up to about 200°C (400°F). As practiced by Porsche, spring steel washers are ideal candidates for this treatment since metal deflection isn't compromised. Other parts that received such treatment included studs and spacers (for lubrication), lock washers, spring seats, tension springs, spring nuts, and the flywheel, among other things. The most visible phosphated 356 parts are probably the Bosch distributor spring clips and wheel nuts, which usually show signs of corrosion by now.

Chromium and Nickel Plating

Chromium was of course used on various parts, and possibly bare nickel as well. These non-galvanic decorative electroplated coatings are easier to identify than galvanic coatings because of their non-sacrificial nature. These coatings are not commonly used for fasteners and the cost is greater than zinc or cadmium. Nickel will tarnish if not followed by chromium, but may have been used on some Bosch component parts. We'll not cover either here, though nickel plating is similar to zinc and can be safely done at home.

Doing It Yourself

This article isn't really a how-to on plating and coating since there are resources available with sufficient instruction and detail. Instead, I'll attempt to describe some of important things to consider and what to expect when attempting your own coatings.

DIY Electroplating

For galvanic electroplating, you should first convince yourself that zinc is the best choice today for most parts and hardware. In harsh environments, zinc may not retain its original as-plated appearance quite as long as cadmium. And the lubricity of zinc is bit less than for cadmium. But cadmium can only be plated at facilities with proper environmental and contamination control. And look again at that picture of the fifty year old zinc plated pulley bolt. It looks to have aged just as well as the cadmium plated pulley.

Most electroplating is done in tanks for cleaning, rinsing, etching, neutralizing, and plating. For an at-home set-up, five gallon plastic buckets suffice for small to moderate sized parts and larger parts can be coated in sections. The picture below shows my set up for the zinc plating tank, with a ½" copper pipe plating bar, an aquarium heater able to get to about 95°F, an aquarium pump for circulation, a copper wire bus loop surrounding the bucket, and a pair of zinc anode plates. The plating solution is made with distilled water and the proper salts necessary for zinc electroplating. The how-to for all of this has been made fairly easy by Caswell Inc. in Lions, NY, who specialize in small batch electroplating. Getting the chemistry right is a matter of buying one of their chemical kits that contains plating concentrates, a brightener, a degreaser, anodes, and a very thorough instruction manual. Good results aren't too difficult if you follow some simple steps. The process progresses

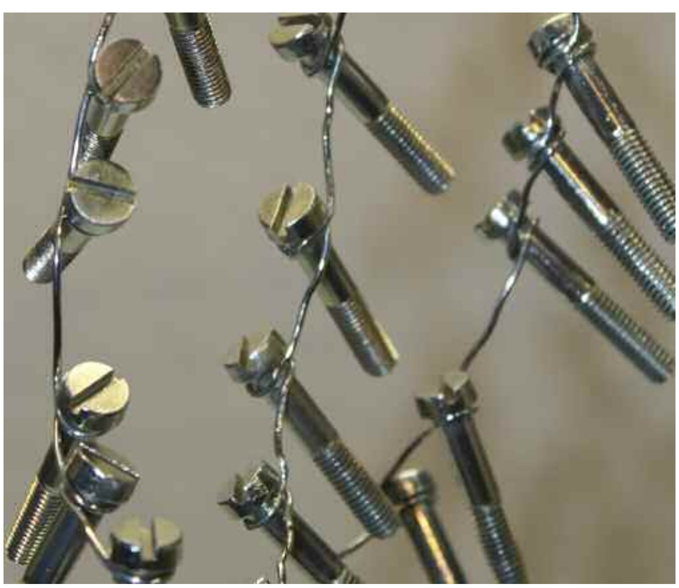
The zinc electroplating tank using a five gallon bucket. Anodes are on either side of the parts which are suspended with wire from the top plating bar.

through surface preparation and degreasing, rinse, acid etch, neutralize, rinse, plate, rinse, and chromate treatment (if desired but not necessary for 356 parts). Each of these steps should be done in a separate bucket tank, though you could combine some of the rinse steps. I use a crock pot for degreasing since it should be heated just below boiling. The most important areas where you don't want to cut corners are with cleaning the parts beforehand and choosing a power supply that is up to the task.

Powering the Process

Electroplating needs DC power and the ability to control the current drawn throughout the plating process. The amount of surface to be plated will dictate the current needed from your power supply, which changes with every run. So a car battery, a battery charger, or an ordinary transformer will not work. A constant voltage power supply is also not good enough. What is needed is a good quality supply with control over constant current (CC) and constant voltage (CV). Without tight control over both, uneven plating and poor adhesion can be expected. The voltage needed is 3-5V and current up to 5A is probably enough for decent size plating runs. You can spend a lot of money on such a supply, with industrial ones running many hundreds of dollars. The one pictured above is a 0-20V and 0-5A controlled supply that I found at a fraction of the original price on the big on-line auction site. Ones like this are much better than the smaller new supplies you'll find from various electronics importers.

Plating times and current settings will depend on the surface area of parts plus that of the wire you'll use to string them. The picture below shows the results from plating a batch of screws wired with copper and connected to the plating bar. Based on the total surface area, the plating current was about 3A at a voltage setting of 3V for 15 minutes. Caswell



provides some handy on-line tools for calculating all of this. I trace parts out in a notebook and note their surface area so I can refer back to something when I plate the same part type again.

Before Plating: Cleaning

Getting parts clean, free of rust, and prepped is critical for results you'll be happy with. This is true also for parts you'd send out for plating. Several approaches can be used. I use a combination of ultrasonic cleaning, tumbling, wire-wheel brushing, filing, and sometimes media blasting. An ultrasonic bath with hot water and a small amount of degreaser can clean the grime off of parts in a few minutes. A rotary tumbler works well about 2/3 full with parts covered with water and a little degreaser. Add old screws, nuts, nails, etc. if you haven't enough parts to reach 2/3. Running the tumbler a few hours cleans small parts well without damaging them. A fine wire wheel works well also and a thin file is usually needed to clean out screw slots. The bottom line is that plating will not cover anything up. Defects, dirt, and rust will ruin a good plated surface. Cleaning is followed up by etching in 15% muriatic acid to remove any remaining zinc or cad coating, followed then by a long water rinse. Again, this is also good practice for parts you prepare for a plater.

A small ultrasonic cleaner (left) and a rotary tumbler (right) for parts cleaning. Vibrating tumblers are also available.

For me, the initial outlay of time and money is well worth the investment. When I need to plate a batch of parts, I clean them up, heat up the plating bath and degreaser, and spend an hour or so for a few plating runs. They're ready to go the same day. I probably recouped my investment in the set-up after a few months.

DIY Phosphating

As mentioned earlier, phosphating is not electroplating but instead a chemical conversion treatment. Several companies provide the supplies for phosphating, including Brownells in Montezuma, IA and Caswell (for a low temperature process). The preparation steps are similar to electroplating. A crock pot is best for high temperature degreasing followed by hot water rinsing and a hot phosphate/acid bath. This is followed by another rinse and a room temperature oil dip to improve corrosion resistance. The near boiling temperature of the phosphating solution is much higher than can be reached with an aquarium heater so a porcelain metal canning pot and a hot plate are needed. Once you've got the set-up put together, the process of soaking parts is much simpler than electroplating. Pictured on the previous page are Bosch distributor clips that were phosphated and oiled. Whereas electroplating is a useful process to have at home, unless you have other reasons for phosphate coating, this may be hard to justify. The cost is relatively low but it does take up some space. In many cases, an old phosphate coating can be cleaned enough and re-oiled to last for many more years. But for parts with nothing left of the original protection, replacing the coating is the best solution.

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