For Light Metal Die Castings, Consider Hard Anodizing

Luke Engineering moves to a state-of-the-art facility to handle the growing demand for hard anodizing . . .

Economics and government regulations have shelved more than one expansion project. In many cases, management feels the rewards do not justify the risks and road blocks. This is not so at Luke Engineering and Manufacturing Co., Wadsworth, Ohio. The 30-year-old company specializes in aluminum and magnesium hard-coat anodizing, serving customers as far away as Florida and Texas. Recently, the company finished a state-of-the-art facility dedicated to aluminum hard coating, including hard coating light-metal die castings.

During the planning process, the company studied every phase of the anodizing process to determine the ideal equipment and design for optimum quality, productivity and minimal environmental impact. The study led to the design and building of the new facility.

Hard anodizing light metals. The new facility will handle traditional hard anodizing as well as new processes that Luke Engineering has developed for hard anodizing light-metal die castings.

LukonDC for aluminum is an anodic process that forms a hard ceramic layer on aluminum die castings. The treatment takes place in an acid bath composed primarily of sulfuric acid fortified with proprietary additives. The parent metal combines with elements in the electrolyte to form aluminum oxide with available silicon co-deposited from the base alloy.

The coating forms in a hexagonal structure with a cylindrical pore extending perpendicularly from the surface of the coating to the active barrier layer. Excess silicon, copper and other elements in the alloy interfere with coating development by obstructing the orderly crystalline formation. The special techniques in the process encapsulate non-reactive elements, such as silicon, into the coating. Electrically active elements, such as copper, are diffused out of the layer.

Magoxid-Coat is formed as an an-

RINSE WATER is added to the back tank with the overflow cascading into the front tank.

odic process on magnesium die castings. The magnesium component is connected anodically to a rectifier. After immersion in a specially formulated, slightly alkaline bath, power is applied and the parent metal combines with elements in the electrolyte to form magnesium-aluminum oxide.

The outermost portion of the coating is formed into a porous ceramic layer. The middle ceramic oxide formation, which is virtually non-porous, provides the majority of the corrosion protection. The innermost barrier layer is extremely thin.

Hard Anodizing. Hard anodizing aluminum has grown dramatically since its 1950's commercial introduction into the aircraft market. Today, it is found on a variety of items from gourmet cookware to tire-building equipment.

The hard-anodized coating is aluminum oxide formed by the electrochemical reaction of aluminum with oxygen. In the process, the aluminum part is racked to make it the anode. It is immersed in sulfuric acid. This produces an oxide film that is chemically bonded to the underlying substrate and is readily measurable. In the case of a 0.002-inch coating, a growth of 0.001 inch will occur. The other 0.001 inch is found below the original surface of the part. This apparent 1:1 ratio of buildup versus penetration tends to hold true for most alloys and coating thicknesses.

The crystallized structure of the aluminum oxide is porous and the coating is made up of millions of tiny pores that extend from the base metal to the surface. This permits extensive buildup of the coating and the introduction of dyes and lubricants. The coating will produce colors primarily in the gray tones with some variations.

For Light Metal Die Castings, Consider Hard Anodizing . . .

HARD-ANODIZED parts include light metal die castings

An important characteristic of hard-anodizing is the crazing pattern that forms. This results when the coating is produced under compression. This condition increases the micro-inch finish from that found on the part before coating. This increase will be higher on castings than on wrought alloys.

Hard-anodized coatings are produced in the sulfuric acid electrolyte at temperatures ranging from 10 to 52F, with current densities from 20 to 250 asf. High current densities produce thick coatings in relatively short times. Using 250 asf, a 0.002-inch coating can be produced in five min. This rapid formation reduces the solvent action of the electrolyte on the first formed oxide and tends to leave it denser and harder than conventional films.

The production of hard anodic coatings seems to vary with regard to sulfuric acid concentration, temperature and current density. Basic requirements appear to be temperatures below 52F, sulfuric acid concentration above five pct and current densities above 20 asf.

Luke Engineering's new anodizing line consists of 15 tanks. The cleaning tanks, both in-line and at a separate degreasing station, use alkaline cleaners. There are no solvent cleaners used.

Three anodizing tanks on the line have an air-curtain exhaust system. Air is blown across the tank, capturing the tank fumes that are exhausted on the other side of the tank. The exhausted air is run through a water-wash scrubber to remove acids. Finally, the pH of the water is neutralized and the water reused.

Process Control at Luke Engineering begins with order entry. When a job enters the system, it is logged into a computer. If it is a repeat job, the data are pulled up on the computer and printed. The printout includes a bar code that identifies the job throughout the shop and contains information on the anodizing cycle.

The operator scans the bar code into the computer and the anodizing parameters are set for the system. Central to quality is the computer-controlled anodizing rectifier systems. A variation in voltage, current or time can adversely affect the finish, even “burn” it. To prevent this, the rectifier system samples electrical current and voltage 400 times per second and makes immediate corrections.

Operators oversee quality throughout the process. The part is continually monitored for cleanliness, deoxidation and uniformity of finish. Process variables such as rinsing and agitation are monitored through constant visual inspection. If an operator has concern, he can use a hand-held thickness tester to immediately sample the work piece. The tester measures anodizing thickness to within plus or minus 0.0001 inch.

Coating Properties. Usually hard-anodized coatings can be held close to tolerances. Thickness variations of up to plus or minus 20 pct are considered normal, with tighter control possible. Good throwing power keeps the coating fairly uniform.

Hardness of up to 70 on the Rockwell C-scale has been estimated. The softness of the underlying aluminum makes accurate reading difficult and can lead to coating failure in applications with point loading.

OPERATORS oversee quality throughout the anodizing process

Aluminum oxide is an extremely abrasion and corrosion resistant material. In Taber-abrasion/wear tests, hard-coated aluminum panels outperformed chromium-plated steel. Hard-anodized parts have withstood more than 5,000 hrs of five pct salt spray testing as well.

Breakdown voltages as high as 2,000 volts have been measured on hard anodized surfaces. The coating can be masked off to provide electrical contact. Aluminum oxide is also a good thermal resistor. This evens out heat flow and eliminates hot spots.

Pollution Control. Luke Engineering designed and installed a closed-loop rinse-water-purification system for the plant. The rinse tanks cascade, with the back tank overflowing into the front tank. From here the water is piped to a resin bed that filters and deionizes the water. The DI water is returned to the rinse tanks for reuse.

When the resin beds from the ion exchange system are full, they are backwashed. The backwash, now laden with metal ions and contaminants, is sent to a holding tank that feeds the evaporator. Here, purified water is evaporated away, leaving a sludge behind. The sludge is sent to a reclaim facility for metal recovery.

Cooling the Anodizing Tanks. Another environmentally efficient system at the new facility is the refrigeration system used to cool anodizing tanks. In place of Freon 12, the compressor uses the refrigerant substitute 134A. The system supports one-and-a-half anodizing shifts daily.

Many factors must be considered when designing a hard anodizing facility. Not only must you think about the process and all it entails, but you must consider the market, productivity, quality and environmental issues. Luke Engineering has successfully merged all of these factors into one successful facility. **PF**

More Information?

To obtain more information on products or processes mentioned in this article, circle corresponding numbers on the Reader Service Card.

Hard anodizing .... Circle 280

To request an additional copy of this article, write on company letterhead to "Reprints," c/o PRODUCTS FINISHING, 6600 Clough Pike, Cincinnati, OH 45244.