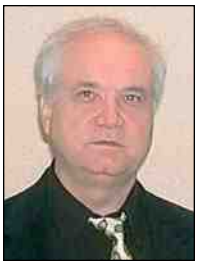

Advice & Counsel

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Aluminum

Dear Advice & Counsel,
I am the new foreman at an airline plating shop and my experience in metal finishing is minimal. I was wondering if you could provide me with a quick primer on the kinds of metals used in the airline aerospace industry.
Signed, New Guy

Dear New Guy,

We will continue our discussion of aluminum which we began last month.

Once formed into parts, some aluminum alloys (especially those used in aerospace) are typically given a heat treatment designed to produce the desired strength. The strength is determined by a complex combination of alloy composition, temperature and heat treat time.

Aluminum alloys that are commonly heat treated include 2000, 6000 and 7000 series (except 7072), and 200, 600 and 700 series casting alloys. Most heat treatable aluminum alloys contain a combination of magnesium and one or more of the following: copper, zinc and/or silicon. Heat treated aluminum alloys are typically designated by the letter "T" (for a few treatments a "W" is used) and a letter designating the type of heat treatment.

Heat treating can be done to enhance the properties desired in either an intermediate or final stage of processing. Aluminum can be hardened, strengthened, treated to relieve internal stresses, softened (tempered), annealed to change structure, impregnated or solution / precipitation-aged.

Control of heating and cooling rates and furnace atmospheres are very important in any thermal treatment process. From a surface finisher's standpoint, it is important to recognize that improperly heat treated metals can present problems. If a constituent that is normally in solution or exists in a finely dispersed form, changes to agglomerated precipitates, because of a heat treatment error, subsequent chemical processing can result in preferential attack of the alloying elements or the surrounding aluminum, resulting in pitting, rough surfaces, discontinuities and structural weakness after processing for anodizing, chem film or plating.

For high volume operations, a microstructure examination at incoming inspection may reduce the number of parts rejected after processing. Because strength properties are often affected by improper heat treatment, mechanical tests such as bend, hardness or tensile tests may be employed to verify proper heat treatment.

Aluminum alloy designation

The international alloy designation system is the most commonly used one for identifying an aluminum alloy. However, there are numerous proprietary aluminum alloys as well (example MIC-6).

In the international designation system, wrought aluminum alloys (meaning any alloys not for use in casting) are designated by a four digit numbering system. The four digits may be followed by a letter, or letter plus number(s), indicating the surface treatment that has applied. Some common temper designations are:

F - As fabricated. This alloy may acquire some temper in shaping, but is not heat treated or strain hardened.

H - Strain-hardened (increased strength). The letter is always followed by two digits, the first indicating a specific combination of basic operations, while the second indicates the final degree of strain hardening. Example: 1100-H24 = strain hardened and partially annealed.

T - Heat treated with or without strain hardening
T3 - Heat treated and cold worked to improve strength
T6 - Heat treated, not cold worked, aged at elevated temperature
T8 - Heat treated, cold worked, aged at elevated temperature

Cast aluminum alloys

Cast aluminum alloys typically are designated by a three-digit system with an optional letter designating an alternate version of the alloy, as shown for the die casting alloy 356 and A356. The 356 alloy contains 7% silicon and 0.3% magnesium, while the "A" version has the same basic composition plus a limit of 0.3% maximum on iron. The 356 alloy is commonly used for permanent mold or sand casting, while the 380 and 390 alloys are commonly used for die casting. Aluminum casting alloys typically contain large percentages (as high as 14%) of silicon.

Wrought aluminum alloys

The 2000 series aluminum alloys are widely encountered in the airline / aerospace industry. Commonly encountered alloys include 2024, 2017 (rivets) and 2014 (forgings). These alloys contain copper (primary), manganese and magnesium as alloying constituents. 2000 series alloys, especially 2024,

may be heat treated to various surface conditions. These alloys typically can be spot welded, friction welded, but not fusion welded.

2000 series alloys offer good formability in the annealed tempered condition. Formability in the age hardened or solution treated condition is significantly lower. They also offer excellent strength-to-weight ratios and excellent fatigue properties, but relatively poor corrosion resistance due to the formation of galvanic cells with the copper in the alloy.

These alloys are readily electroplated, anodized and chem film treated. Hard coat anodizing these alloys using conventional anodizing processes can be difficult. Proprietary processes for hard coat anodizing 2000 series aluminum are available.

The 5000 series alloys contain magnesium as the primary alloying element. While not heat treatable, these alloys offer higher strength-to-weight ratios and are better suited for anodizing than the 3000 series alloys, which are not commonly used in aerospace.

The 5000 series alloys offer excellent formability, good weldability and good fatigue properties. Some 5000 series alloys are suitable for use as rivets. 5052 is an alloy that offers the highest strength in this series. It offers good corrosion resistance in marine applications as well.

The 6000 series alloys contain magnesium and silicon as the major alloying elements. These alloys are heat treatable, offer good fatigue resistance, good formability, and can be welded and brazed. Popular 6000 series alloys used in the aircraft industry are 6061 and 6063. These alloys offer better corrosion resistance than 2000 or 7000 series, but cannot provide the same level of strength. 6063 is especially suitable for producing parts via the extrusion process. These alloys can readily be electroplated, anodized and chem film treated.

The 7000 series alloys contain zinc as the primary alloying element. These alloys offer the highest strength-to-weight ratio (with the exception of some proprietary alloys) and are commonly found in airline / aerospace applications. The 7000 series alloys offer excellent fatigue properties, but may be inferior to other alloys when in the T6 condition (these alloys are normally formed in the annealed condition). 7000 series alloys can be spot welded, but not fusion welded. They are poor in corrosion resistance, unless electroplated, anodized, chem film treated and/or painted. 7000 series alloys are almost always cladded when not anodized, chem film treated and or painted. ***P&SF***

Test Your Plating I.Q. #466

By Dr. James H. Lindsay

Wastewater treatment: Flocculants

1. What is the difference between flocculation and precipitation?
2. How does a flocculant work?
3. How does a coagulant differ from a flocculant?
4. Flocculant-water mixtures can be stored indefinitely (True or false).
5. Flocculation requires vigorous agitation (True or false).

Answers on page 20.

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$5,000

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