Aviation Week & Space Technology

Brooklyn, NY – A superplastic fabricating process, patented by McDonnell Douglas Corp., now (Boeing) heats a sheet of titanium to its superplastic temperature directly inside the forming press; no furnace is necessary. Energy from the heat source, a bank of 1600W infrared (IR) lamps, is directed to the metal via a water-cooled, gold-plated reflector. Pressurized argon gas forces the sheet into the die.

An electrodeposited gold, developed by Epner Technology Incorporated, makes this possible by providing a better than 98% reflector efficiency. Called "Laser Gold" (the material is the industry standard coating for pump cavity reflectors of Nd:Yag solid-state lasers), the coating permits repeated physical cleaning with no apparent wear or degradation of reflectivity.

Problem:
Used by the McDonnell Douglas St. Louis facility to fabricate parts for the F-15 Eagle and the F-18 Hornet aircraft, the superplastic forming process (SPF) originally employed a polished aluminum reflector. High temperatures, however, promoted oxidation. The reflector, consequently, was disassembled on a monthly basis, repolished, and then reassembled. Polishing compound inadvertently left on the reflector surface stimulated even faster oxidation.

At best, the aluminum surface reflected only 75 to 80% of the incident IR energy. To boost efficiency, the company considered conventional gold plating. Coatings produced by vapor deposition offered the desired reflectivity (95 to 98%) but wiped away with successive cleanings. Ordinary electroplating produced a hard coat, but the relatively small increase in reflectivity (approximately 10%) did not justify the added expense.

Solution:
"Laser Gold" combines the high reflectivity of vapor deposition with the durability of electroplating. Impervious to high temperatures generated by the IR lamps, the coating eliminates oxidation. No oxidation, in turn, eliminates disassembly and repolishing. Occasional lamp removal for surface cleaning constitutes the only required maintenance.

Plating begins by polishing the aluminum reflector to an RMS 4 finish. Degreasing and an aluminum preplate preparation using the zincate process follow. Since aluminum cannot be directly plated with gold, an electroless nickel plating precedes gold deposition.

The nickel, deposited to a minimum thickness of 0.001 inch, acts as a barrier between the aluminum and gold, preventing the gold from diffusing into the aluminum. It also

provides a better bond for gold plating. Once deposited, the nickel plate is buffed and electrochemically activated prior to gold plating.

Electrodeposition of a gold layer measuring at least 100 uinches in thickness, makes up the last step. Although electroplating traditionally calls for direct current, Epner Technology Incorporated superimposes ac on the dc. Repeated pulses of electricity and trace amounts of proprietary additives, product the coating's unique crystalline structure. The structure, different from that formed by conventional electroplating, gives the gold near optimum reflectivity at IR wavelengths between 2 and 5 microns.

Another factor contributing to the coating's overall performance involves, when applicable, a plating/deplating procedure. The company plates the substrate metal for several seconds, reverses polarity, and "deplates" for a shorter interval. The cycle is then repeated several times. The entire process took more than 15 years to develop.

Additional benefits, applications:
Besides bringing the titanium sheet to its superplastic temperature, the high-power, IR lamps preheat the female die – the large mass of steel below the titanium sheet. Since the "Laser Gold" reflector absorbs less than 2% of the energy striking it, more energy is directed at the die. This translates to significant decreases in cycle times and/or power reductions ranging up to 50%.

The electrodeposition process applies not only to aluminum, but to a variety of substrates. These include molybdenum, beryllium, magnesium and titanium. When a vacuum deposited binder coating is applied to dielectric materials, they too can be electroplated with gold. IR missiles; countermeasure systems designed to protect aircraft (including Air Force One and the Space Shuttle vehicles) from IR homing missiles; and use in IR ovens for industrial purposes (e.g., curing rubber, drying paint, etc.) represent current applications.

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