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NASA TECH BRIEF

Marshall Space Flight Center

Selective Coating for Collecting Solar Energy on Aluminum

The problem:

Coated aluminum substrates used as collectors of solar heat require a high solar radiation absorptance and a very low thermal and infrared emittance. The efficiency of such coatings is determined by the ratio α/ϵ, where α is the absorptance and ϵ is the emittance: the larger this ratio, the higher the collector efficiency. Presently used coatings, which were originally developed for brass, copper, and steel substrates, yield relatively low α/ϵ ratios when applied to aluminum.

The solution:

A new, efficient, black-nickel plating applied to aluminum substrate enhances solar absorptance to 93 percent and reduces the emittance to 6 percent.

How it's done:

Aluminum, unlike other common metals, requires a special treatment to make it receptive to an electroplate. The entire process requires anodizing the substrate in an acid bath to produce a thin porous oxide film, plating the anodized surface with bright nickel, and finally plating the surface with black nickel.

Specifically, an aluminum surface is anodized for 10 minutes in a 350-gram phosphoric acid solution diluted in 1 liter of water. This process is carried out at a current density of 12 A/ft^2 (130 A/m^2) and a bath temperature of 80° F (26° C), using a lead cathode. The anodized substrate then is placed into a nickel bath containing the following:

Nickel sulfate ($NiSO_4 \cdot 6H_2O$)	10 oz/gal (70 g/1)
Nickel chloride ($NiCl_2 \cdot 6H_2O$)	8 oz/gal (56 g/1)
Boric acid	5.5 oz/gal (38.5 g/1)

This solution includes special brightener and nonpitting agents constituting 7 percent of the bath volume. The plating process is carried out at a current density of 20 A/ft^2 (215 A/m^2) and a bath temperature of 120° to 140° F (48° to 59° C) for approximately 30 minutes, the time necessary to produce a nickel coating thickness of approximately 0.5 mil (0.01 mm).

The plated surface then is buffed, cleaned in an alkaline solution, dipped into a 30-percent hydrochloric acid solution, rinsed, and introduced into another nickel bath. The second bath composition contains the following:

Nickel sulfate ($NiSO_4 \cdot 6H_2O$)	10 oz/gal (70 g/1)
Nickel ammonium sulfate [$NiSO_4(NH_4)_2SO_4 \cdot 6H_2O$]	6 oz/gal (42 g/1)
Zinc sulfate ($ZnSO_4 \cdot 7H_2O$)	5 oz/gal (35 g/1)
Sodium thiocyanate (NaCNS)	2 oz/gal (14 g/1)

Plating is continued for the period of time necessary to produce a surface with a solar absorptance of 0.9 and a thermal or infrared emittance of 0.06. This time is determined empirically. In general, 5 minutes of plating time at a current density of 0.5 A/ft^2 (5.4 A/m^2) are sufficient to produce these optical qualities.

Notes:

1. This process may be of interest to engineers and scientists investigating new sources of energy.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&PS-TU
   Marshall Space Flight Center, Alabama 35812
   Reference: B73-10527

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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Category 03, 04, 08