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Brief 71-10110

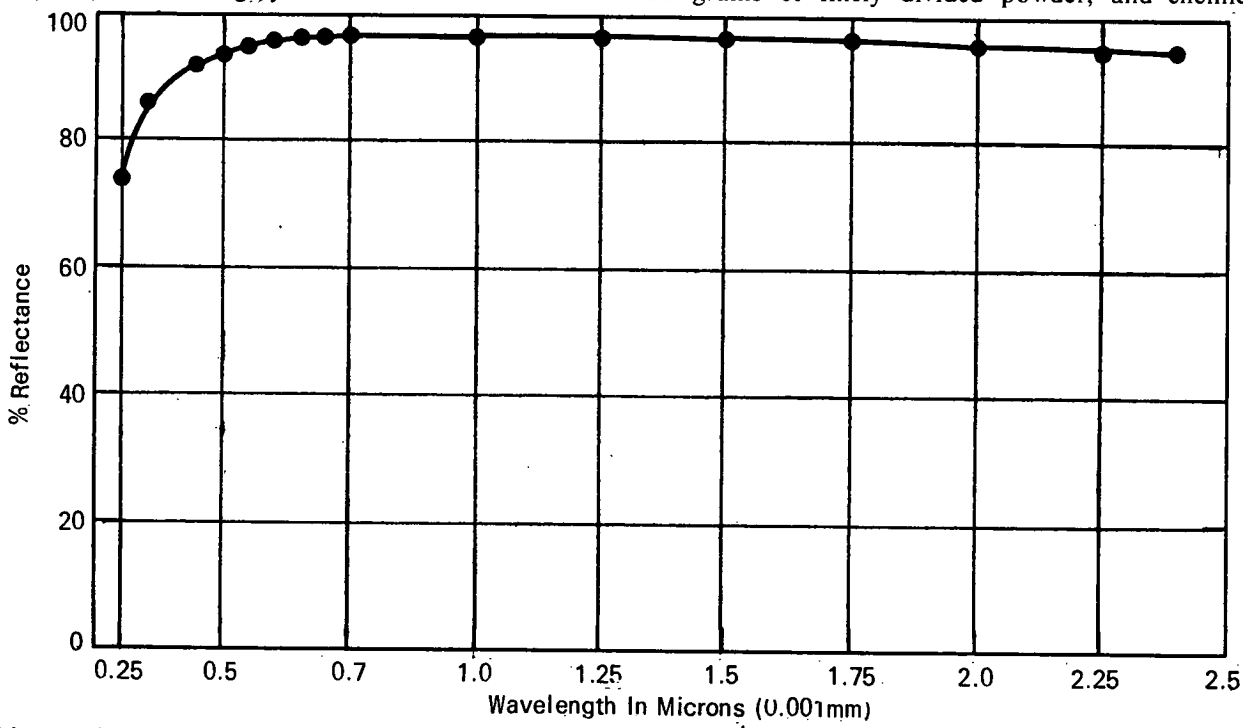
NASA TECH BRIEF

Goddard Space Flight Center

Improved Reflective Coating for Integrating Spheres

The problem:

Design an improved coating for an integrating sphere (for measuring total reflectance) that is perfectly diffuse and highly reflective. The best available coating, MgO, requires a thickness of 3 to 4 mm, takes from 3 days to 2 weeks to cover a sphere, has poor adhesion and cohesion, is fragile, deteriorates in the presence of moisture, and requires annual replacement.



The solution:

Wet-spray apply certain inorganic salts or oxides such as NaF, BaF_2, KCl, Al_2O_3, or preferably NaCl. The material should be transparent (non-absorptive) in single-crystal form; have a high index of refraction, smooth cleavage or growth surfaces on grains of finely divided powder, and chemical stability (lack of a stable hydrated phase at 294°K (70°F) and of moderate deliquescence); be stable to the radiations of interest, partially soluble and easily dispersed in a liquid for spraying, and readily dried (cured) with reasonable cohesion and adhesion; and have good mechanical stability.

How it's done:

Typically, an extremely pure mixture (by weight)

(continued overleaf)

of 40% NaCl and 60% ethyl alcohol (absolute) is ball-milled for from 1 to 3 days in a sealed alumina jar before the other constituents are added. With NaCl, the final coating mixture comprises (by weight) 20% NaCl, 10% propylene, 10% xylene, and 60% ethyl alcohol. Permissible ranges are 10-30% NaCl, 5-15 low-boiling diol (1,3 butanediol), 0-20% xylene or toluene, and 40-80% alcohol (100% ethyl or 100% isopropyl).

The substrate (aluminum, steel, or plastic) should be sized (e.g., with a silicone) to prevent discoloration. The best relative humidity for application and cure is between 10 and 35%, with 20% preferred. The coating is conventionally wet-sprayed, and then dried in circulating air at room temperature, followed by a 313°K (40°C) cure.

The edges of an integrating sphere are best trimmed on the second day while the coating is still moderately moist. If the coating is still sufficiently pliable, cracks formed during the cure can be closed with a very clean finger; if not, the cracks can be opened and filled with a stiff paste made by evaporation of the coating mixture. When the coating starts to whiten, it is baked in a circulation oven with the temperature slowly raised (at a rate of 10°K, i.e., 10 °C, per day) to 333° or 343°K (60° or 70°C) for aluminum substrates; the temperature depends on the difference in thermal expansion coefficient between coating and substrate. Subsequent damage to a coating is repaired by removing the affected area, applying an NaCl paste, and then curing. When cleaning a sphere necessitates resurfacing, a light and relatively dry layer is applied with a mixture of NaCl and alcohol only.

Final completion takes from 3 to 7 weeks, of which 1 or 2 hours are spent in work. The thickness required for opacity is from 1 to 2 mm, depending on the density of the coating. The absolute total reflectance of NaCl is 95% within the solar region; and water of adsorption, though occasionally present, does not impair performance.

Note:

Requests for further information may be directed to:

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Reference: TSP71-10110

Patent status:

No patent action is contemplated by NASA.

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