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NASA TECH BRIEF
Goddard Space Flight Center

Integrating-Sphere Coating

The problem:

An integrating sphere is a device used for measuring the total reflectance of materials. The sphere has a hollow cavity inside, which accepts a standard reference and a sample to measure the total reflectance of the sample either absolutely or relatively. The cavity is coated with a highly reflective material which collects and directs light entering one aperture of the sphere toward a second aperture containing a photocell to measure light intensity. The coating used at the present time consists of magnesium oxide deposited by burning or smoking magnesium metal in air and letting it settle on the inside surface; this process is very slow and requires some precision. In addition, magnesium oxide coatings are extremely fragile, have very poor adhesion and cohesion, and are difficult to apply.

The solution:

Sodium chloride, used with a proper solvent-dispersant combination, forms very durable reflective coatings. Several other inorganic salts, such as barium sulfate, barium carbonate, sodium fluoride, potassium chloride, sodium hexafluorosilicate, and aluminum oxide, are also suitable.

How it's done:

The formulation of sodium chloride coating compositions generally includes: about 10 to 30 weight-percent sodium chloride; 5 to 15 weight-percent diol solvent, e.g., propylene glycol or butanediol; about 0 to 20 weight-percent nonsolvent, e.g., xylene or toluene; and about 40 to 80 weight-percent alcohol, preferably ethanol or isopropanol.

In this process, an alumina ball-milling jar, having a silicone rubber gasket to minimize contamination, is charged with 20 grams of sodium chloride and 30 grams of absolute (200-proof) ethyl alcohol. The suspension is ball milled for three days, at which point 10 grams of propylene glycol, 10 grams of xylene, and an additional 30 grams of absolute ethyl alcohol are added; and the formulation is thoroughly mixed.

An aluminum integrating sphere is cleaned for a period of about 10 to 15 minutes, by immersion in a 20% solution of sodium hydroxide at a temperature of about 40° C. The sphere is then removed from the bath, rinsed with distilled water, and dipped for about 5 minutes in an aqueous solution of about 1% hydrogen fluoride and 5% nitric acid; this procedure is followed by a number of additional rinses with distilled water. The sphere is then dried and coated with an alkali metal-silicate sizing solution, to reduce porosity and to inhibit corrosion of the surface by sodium chloride. To prevent migration of alloying materials from the aluminum into the sodium chloride coating, the surface is coated with a silicone resin.

The coating composition is sprayed upon the integrating sphere by a conventional wet-spray gun under controlled conditions of about 20% relative humidity. The interior surface of the sphere is given four individual coats of about 1/2 mm in thickness each. Drying time between each coat is about 5 to 10 minutes at 40° C. The coated sphere is left overnight in the 20% relative humidity, at an ambient temperature, and then is placed in a circulating oven at a temperature of about 40° to 50° C. After about 2 days in the oven, the coating becomes a white reflective surface. The oven temperature is then raised about 10° C per day to about 70° C, where it is maintained for a period of about 48 hours. The heat is then progressively reduced, at the rate of about 10° C per hour, down to the ambient temperature; and the sphere is removed from the oven.

The resultant coating is hard, adheres well, and has an absolute total reflectance of 95% within the solar region. The reflectivity of the coating surface is non-specular. In addition, the coating can withstand considerable thermal and mechanical shock at tempera-

(continued overleaf)

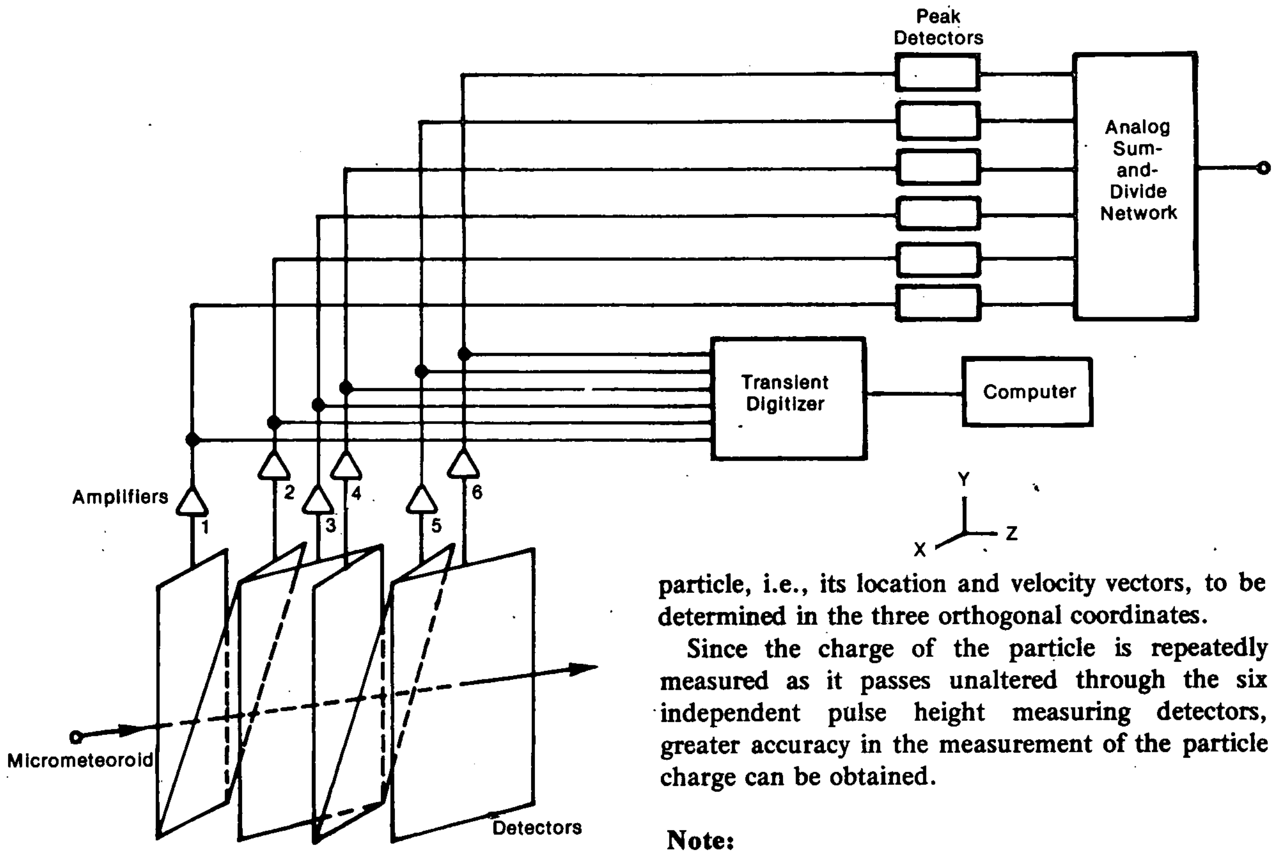

Figure 2. Micrometeoroid Velocity-and-Trajectory Analyzer

The three grids of Figure 1, taken as shown, form a single planar detector. Six of these detectors arranged in three pairs, as shown in Figure 2, enable the position and/or velocity vectors of the particle to be determined relative to three mutually orthogonal axes, X, Y, and Z.

Each of these detectors produces a separate output pulse as a moving charged particle passes through the array. These pulses are amplified, and each is applied to a separate peak detector. The outputs of each of these are then applied to an analog network which, after the passage of the particles, sums them and divides the sum by the number of detectors, thereby giving an indication of the charge of the particle. After the particle passes through the detector, it may be subject to further analysis.

The amplified pulses are also applied to a transient digitizer. It produces a digital output signal indicating the times at which the particle passes through the subsequent planes defined by the detectors relative to the time at which it passes through the first such plane (detector 1). This output signal is then processed by a computer which solves the appropriate sets of equations, based on the geometry and the dimensions of the detector array, enabling the trajectory of the particle, i.e., its location and velocity vectors, to be determined in the three orthogonal coordinates.

Since the charge of the particle is repeatedly measured as it passes unaltered through the six independent pulse height measuring detectors, greater accuracy in the measurement of the particle charge can be obtained.

Note:

Requests for further information may be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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