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NASA TECH BRIEF

Marshall Space Flight Center

Plasma Calcining of Pigment Particles for Thermal Control Coatings

The problem:

It was found that zinc oxide (ZnO) and zinc orthotitanate (Zn_2TiO_4) which are used as pigments for thermal control coatings lose their reflectiveness when they are exposed to ultraviolet radiation. To prevent any damage due to radiation, zinc orthotitanate is heated at temperatures between 900 and 1100°C. Unfortunately, this causes sintering and particle agglomeration, and a subsequent comminution processing step must be used. However, this process apparently damages the zinc orthotitanate pigments. A heat treatment was needed that does not result in agglomeration and sintering, thereby eliminating the need for subsequent comminution of the pigment particles.

The solution:

A plasma technique has been developed which can calcinate fine particles without producing sintered agglomerates. The method uses an rf excited plasma to surface deactivate thermally stable powders at high temperatures. Utilization of this plasma heat treatment at high temperatures can be carried out without grain growth, calcination, or agglomeration.

How it's done:

Particles of silicated zinc orthotitanate pigments were dispersed in a carrier gas (argon and oxygen) and were heated by hot argon produced in an induction plasma. The prepared pigments were injected downstream and were transported into the plasma heating apparatus via the carrier gas. All runs were conducted at pressures between 84.38 and 94.6 kN/m^2 (633 to 710 Torr). The total resultant gas composition in the reactor was 80.7% argon and 19.3% oxygen.

The effect of calcination on pigment powders was determined by characterizing the particles before and after the rf plasma heat treatment. The component materials used in the synthesis of the zinc orthotitanate pigments, the beginning pigment powders, and the rf plasma calcined zinc orthotitanate powders were analyzed for crystal structure chemical phases, particle morphology, particle size distribution, and chemical impurities.

The following conclusions have been derived.

1. The crystal structure of the zinc orthotitanate pigment powders appears to be unaltered by plasma calcinating.
2. The particle morphology is altered to the extent that protuberances and sharp edges are removed, producing a rounding effect.
3. The particles are not appreciably altered in size.
4. The chemical impurities found present in the zinc orthotitanate are from the anatase starting material and, apparently, from the ceramic vessels used during synthesis. Plasma calcinating did not appreciably affect the impurity content.

Notes:

1. This process may be useful to industries involved with ceramics, high temperature materials, or semiconductor oxides.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A & TS-TU
   Huntsville, Alabama 35812
   Reference: TSP72-10320

Patent status:

No patent action is contemplated by NASA.

Source: E. P. Farley of
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Category 04