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Improved Zinc Oxide Thermal Control Coatings

Electron-hole pairs are formed when pigment materials such as zinc oxide are illuminated; light energy is transformed into the energy of the electron-hole pair. In thermal control coatings, the hole can oxidize chemical species in contact with the surface of the pigment particles or even the surface molecules of the pigment itself, and the electron can reduce surface chemical species or the cation of the pigment; as a result, the energy of illumination is transformed into chemical changes of the pigment or the vehicle. Eventually, the thermal control coating is degraded by the accumulation of new chemical species which alter its optical and physical properties.

Pigments used in thermal-control coatings can be improved by inclusion of chemical species which can alternately capture electrons and holes by a cyclic mechanism which regenerates the original species:

$$(1)\ R + e \rightarrow R^-; \qquad (2)\ R^- + p \rightarrow R.$$

The chemical species is termed a recombination center because it leads to the simple recombination of the electron-hole pair with no net chemical change; the energy of illumination is thus converted to heat. Chemical species which can perform as efficient recombination centers exhibit the following characteristics: (a) They form stable oxidation states differing by one electronic charge. (b) They can be applied to the surface of the pigment in adequate quantities and in both oxidation states. (c) They have reasonable capture cross-section for holes in the reduced form and for electrons in the oxidized form.

The results of a study of zinc oxide have demonstrated that the ferricyanide/ferrocyanide couple is very effective for preventing the degradation of the pigment. Zinc oxide pigments doped with the redox couple exhibited marked resistance to chemical changes as determined by measurements of conductivity and optical absorption. If at least 0.3 monolayer of the ferricyanide/ferrocyanide couple is present, neglible changes occur when the pigment is illuminated by ultraviolet light.

Note:

Requests for further information may be directed to:

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Pasadena, California 91103
Reference: TSP 72-10711

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 USC 2457 (f)], to the Stanford Research Institute, Menlo Park, California 94025.

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