NASA TECH BRIEF

Protective Coating Withstands High Temperatures in Oxidizing Atmosphere

The problem:

To provide a protective coating that will withstand high temperatures in an oxygen-rich atmosphere such as the flames of a liquid oxygen-kerosene rocket engine. Used on a thermocouple, it must be thin enough so that response time is not degraded but must protect the base material for a sufficient time to permit proper temperature measurement. It is also desirable to be able to use the coated thermocouple through more than one heating/cooling cycle without cracking, chipping, or peeling.

The solution:

A plasma arc sprayed mixture of hafnium oxide and zirconium diboride.

How it's done:

A mixture of hafnium oxide and zirconium diboride in a 1:1 ratio based on the atomic weight of the metal is prepared with a particle size distribution of between approximately −125 and +325 mesh and an average particle size of about 200 mesh. The powdered mixture is dispersed in an inert gas that passes through an electrical discharge arc at a typical temperature of 3000° to 5000°K. The resultant plasma jet is a hot, fluid, gaseous stream and is directed toward the substrate to be coated, this being surrounded by a cooling atmosphere of an inert gas such as argon. The plasma jet stream condenses on the cooled substrate surface to provide the desired protective coating.

Notes:

1. A coating of the order of 0.002 to 0.050 inch on a homogeneous tungsten thermocouple surface gave good protection, did not flake or crack on subsequent cooling and reheating, and did not degrade the thermocouple response time.
2. This coating withstood a temperature of 4700°F for 5 minutes with no apparent damage to the substrate. Exposure to 3700°F for 30 minutes gave the same result.

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)), to Fenwal Incorporated, Ashland, Massachusetts.

Source: Clarence Howard Mellor
of Fenwal Incorporated
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