Nevada Thermal Spray Technologies (NTST)
Contact: Dominic, cell: 702-449-2154, email: dominic@nevadathermalspray.com

NTST Thermal Protection (TP) Materials

1.0 Executive Summary

NTST has extensive experience in heat management materials, thermal barrier coatings, and ablative materials currently used for many different applications. NTST has now developed economical TP products involving intumescent and non-intumescent material systems that can be utilized for aerospace applications (e.g., heat shields, spacecraft tiles, leading edges, control surfaces, tanks). These non-carbon-based ceramic materials can withstand the rigors of controlled extreme spacecraft reentry. The material systems can be utilized for long-term temperature conditions (i.e., 60 minutes at temperatures of 3500F), and short-term temperature conditions (i.e., 5 minutes at temperatures ranging from 4500F to 12000F).

2.0 NTST TP Materials:

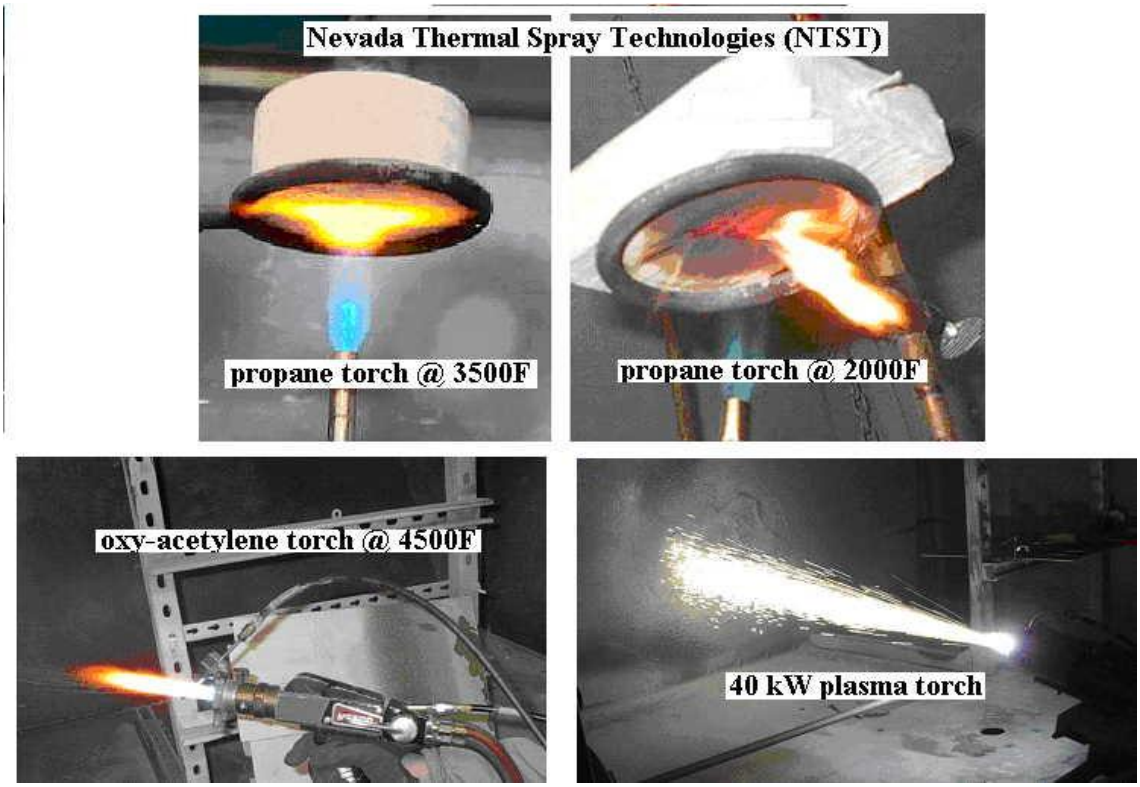
NTST TP materials are the most economical product in the marketplace and can be marketed as a green protective material. The materials are low density (3 gr/cc), inert, non-toxic, and odorless. They are applied using brush, roller, or low-pressure liquid spraying equipment. The materials are reusable being robust enough to survive multiple reentry sequences without repair.

NTST personnel have been involved in past NASA government programs that developed ablative heat shields that are currently being utilized (Lockheed-Martin materials SLA-561 and SLA-220). The NTST TP material formulations can be customized for ablative coating applications with slight formula modifications.

3.0 TP Material Testing Approach

NTST TP materials have been shown to withstand testing temperatures of 2000F and 3500F using a propane torch for long term tests of 60 minutes; and, short term tests less than 5 minutes of 4500F using an oxy-acetylene torch, and 6500F and 12000F using a plasma torch. Torches utilized for the NTST testing are illustrated in Figure 1.

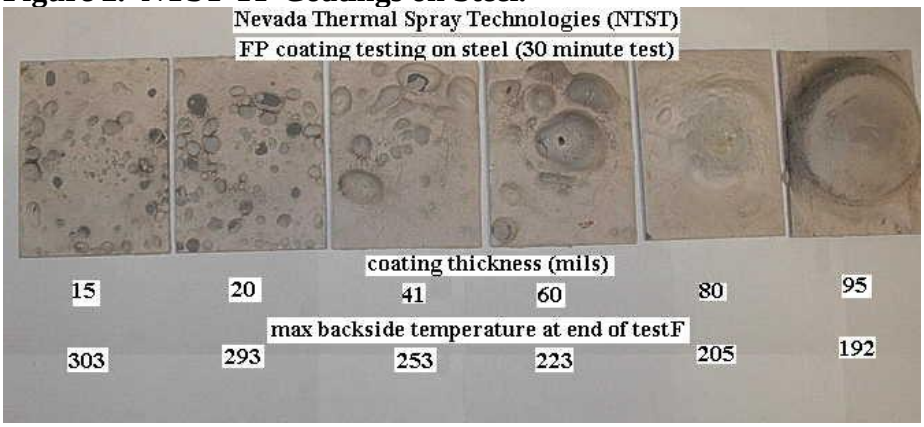
Figure 1. Torches Utilized in NTST TP Material Testing



3.0 TP Materials Testing

The NTST TP materials can be used as a heat management system for many different aerospace applications. Unprotected material structures can reach critical temperatures where mechanical properties are degraded to the point where the material strength is compromised. Successful NTST testing was accomplished, as illustrated in Figure 2, for the NTST TP coatings on steel substrates for 30 minutes using a 3500F propane torch. TP coating thicknesses ranged from 15 to 95 mils. The backside substrate temperature measurements ranged from 192F to 273F for the substrates at the end of the tests. As a result of heat exposure, the NTST TP materials exhibited the typical swelling characteristic of intumescent coatings. Tests were also conducted to determine the reusability of the materials. This involved multiple testing sequences on subsequent days on the same sample at temperatures of 3500F for a total testing time of 30 minutes.

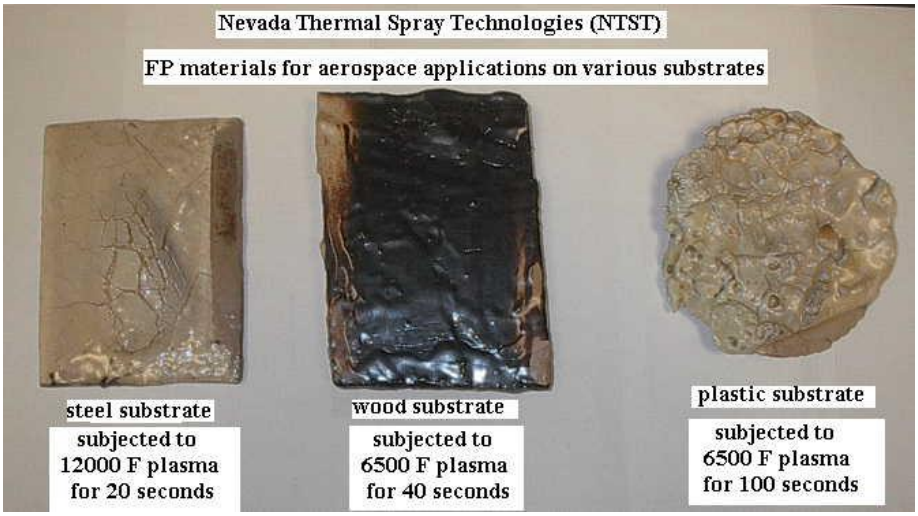
Figure 2. NTST TP Coatings on Steel.



Follow-on testing on the NTST TP materials utilized an oxy-acetylene torch which can reach temperatures as high as 4500F, and a plasma torch which can reach temperatures as high as 6500F at a 2-inch standoff, and 12000F at a 1 inch standoff. An ABB robot was

utilized to traverse the substrates in an x-y scan pattern. As illustrated in Figure 3, an 80 mil NTST TP coating thickness on steel was subjected to a 12000 F plasma temperature for 20 seconds. An 80 mil NTST TP coating thickness on wood was subjected to a 6500 F plasma temperature for 40 seconds. An 80 mil NTST TP coating thickness on plastic was subjected to a 6500 F plasma temperature for 100 seconds. In all cases there was no degradation of the underlying substrates.

Figure 3. High Temperature Testing of NTST TP Coatings.



5.0 NTST High Temperature Materials Capability

Space exploration requires the use of high temperature materials. NTST's prior experience with the space program has involved fabricating coatings of tungsten, rhenium, and tantalum. NTST's product portfolio also includes widely used coatings for aerospace applications including carbides (e.g. tungsten carbide-cobalt, chromium carbide, zirconium carbide, boron carbide, tantalum-hafnium), oxide ceramics (e.g. zirconia, chromia, alumina), iron alloys, steel alloys, super-alloys (MCrAlY), cobalt and cobalt alloys, and polymers.