Nevada Thermal Spray Technologies
Contact: Dominic, 702-449-2154, dominic@nevadathermalspray.com
NTST website: www.nevadathermalspray.com

Boron Carbide (B4C) Coatings

NTST General B4C Information:

NTST has developed the capability to economically fabricate thick B4C coatings. This material is extremely difficult to deposit due to its tendency to sublime at high temperature (i.e. decomposition temperature = 5005 F / 3036 K). NTST can fabricate pure B4C coatings, B4C cermets (B4C+TI, B4C+Ni), and composites (e.g., B4C-SiC). NTST B4C coatings can be deposited on steel, aluminum, graphite, silicon carbide, titanium, and carbon composites.

The pure B4C coatings were designed for use in the nuclear (i.e. neutron attenuation) and food processing (i.e. mechanical seals, shafts) industries. The cermets were designed for use in the oil and gas industry (e.g. valves, shafts, instrumentation). The B4C-SiC composite coatings were designed for use in dual wear-corrosion applications.

B4C Coatings

The superior mechanical properties of B4C make it very attractive for use as a wear coating for industrial machinery and components (e.g. Figures 1a and 1b). B4C is the hardest material next to diamond. Density is 2520 Kg/m3. Thermal conductivity varies from 30-42 W/m-K. Coefficient of thermal expansion is 5 6/C. Dielectric strength is 257 V/mil. These coatings can be used to mitigate wear by abrasive grains, hard surfaces, particle erosion, and cavitation.

Figure 1a. Pump mechanical seals coated with B4C, ground, then lapped

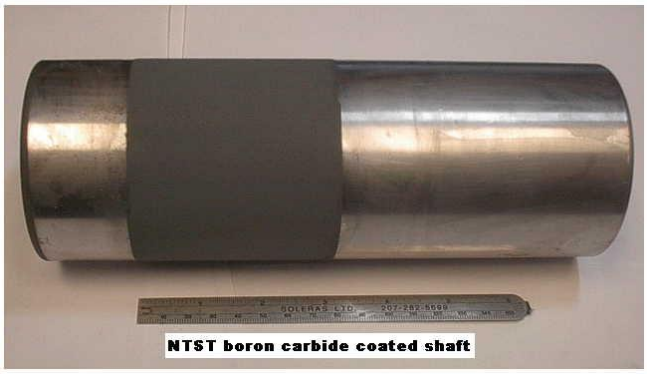

Figure 1b. Shaft coated with B4C

B4C coatings possess high heat resistance and are unaffected by acid or alkaline solutions. The coatings have excellent lubrication and anti-galling properties. Boron has been approved by the FDA, and is used extensively in the nuclear and pharmaceutical industries. Figure 2 illustrates B4C-SiC composite coatings.

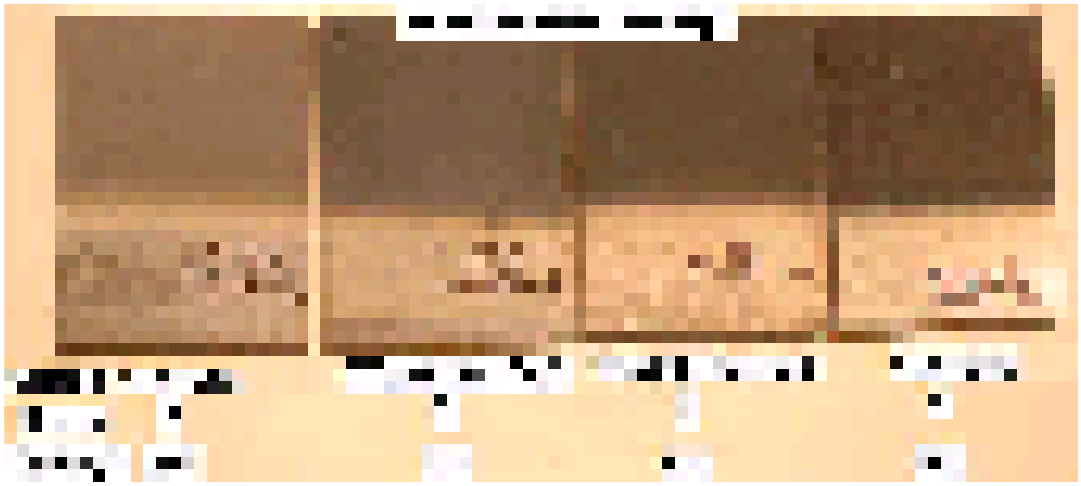

Figure 2. B4C-SiC composite coatings

Boron Carbide Coating Characterization

NTST B4C coatings have been characterized by several outside labs. The coatings are dense, hard, and wear resistant. Porosity is 2%, Mohs hardness is 9.5. Coating bond strength is over 6148 psia. As sprayed coating Ra roughness varies from 205 to 455 microinches as a function of thickness. XRD conducted on the pure B4C coating indicated that the coating was the same composition as the starting powder. Figure 3 illustrates a typical photomicrograph.

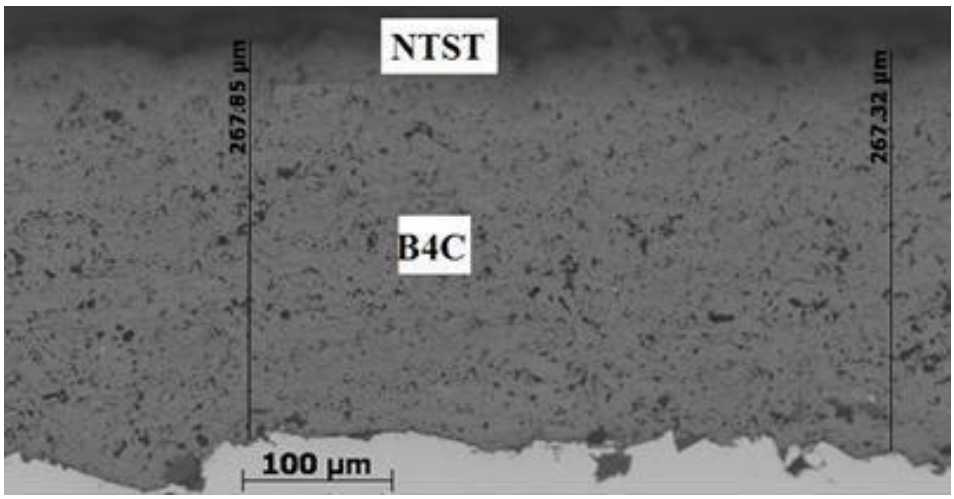

Figure 3. Photomicrograph of B4C.

Boron Carbide Coating Performance Evaluation

Six 130 mechanical pump seals (see Figure 1a) were installed July 2012 in a pump in the Cal Pacific processing plant in Watsonville, CA for strawberry processing. The pump ran for three processing seasons with these seals. The pump was removed prior to the 2015 processing season due to bearing failure. Seals are automatically replaced at this juncture. The B4C seals were in extremely good condition after three processing seasons with minimal wear evident on the seals. Normal chrome oxide (Cr2O3) coated seals need to be replaced yearly.

The oil and gas industry is using NTST B4C coatings in instrumentation used to locate oil and gas. The B4C coating used in this application was sprayed to a thickness of 40 mils (i.e. 0.040") as illustrated in Figure 4. The B4C coatings were successfully tested at 350F and 20000 psi to determine if the coating would be applicable for this application.

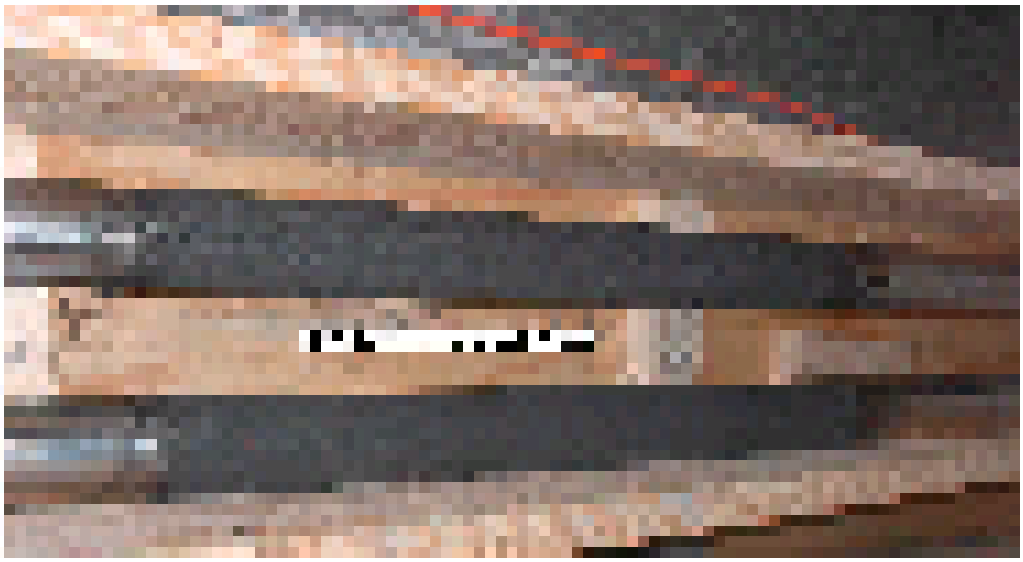

Figure 4. B4C coatings (40 mils) on 12' long titanium rods.

The food processing industry has started replacing Cr2O3 coatings on sleeves and shafts with B4C coatings. The B4C coatings have shown excellent resistance to the mechanical and chemical environment in tomato processing, and have a lifetime 2 to 3 times that of Cr2O3. Figure 5 illustrates a finished sleeve coated with B4C.

Figure 5. Sleeve coated with B4C, ground, then polished.

Boron Carbide Coating Nuclear Applications

Boron is an important material for nuclear applications due to its high neutron absorption cross section. Boron carbide powder and coatings are the best nuclear radiation absorbers for high and low level nuclear applications. Figure 6 illustrates nuclear reactor parts coated with 20 mil thick B4C coatings.

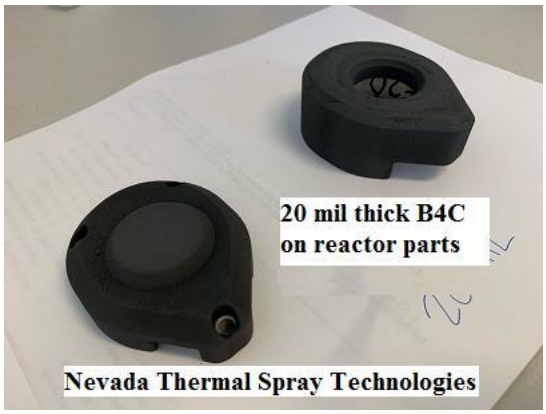

Figure 6. Reactor parts coated with B4C.