NTST
NEVADA THERMAL SPRAY TECHNOLOGIES

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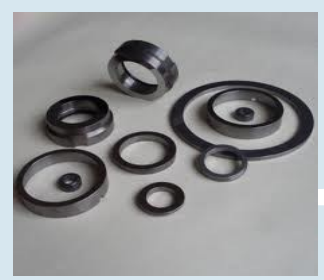
Product/Service Information

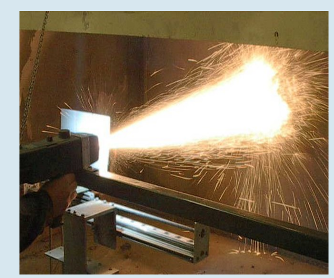
R&D Capabilities

Coating Design and Manufacturing

Our Mission

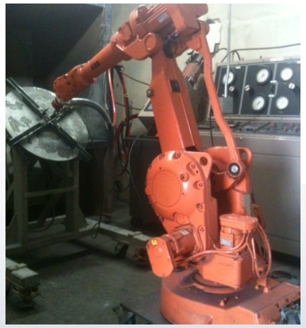
Nevada Thermal Spray Technologies centers on a core competency of superior customer service. The highly technical nature of ceramic and metal coatings often places our customers in unfamiliar territory, and it is our mission to guide the client through the process of defining the problem, identifying a range of solutions, and ultimately manufacturing a world class custom coating. Our dedication to combining materials engineering with an economical focus sets us apart from the competition. We take the time to listen to customers' needs in order to develop unique coating solutions that lower ultimate lifecycle costs at the most diminished lead times in the industry.





Thermal Spray Overview

Thermal spray is a generic term for a versatile group of processes for depositing metallic and nonmetallic coatings. These processes include flame and HVOF (combustion), plasma, electric arc, and nozzle aspirated. Probably the most outstanding feature of thermal spray coatings is their diverse applicability, due to an almost unlimited materials selection that can be applied to practically any substrate. Coating materials include all types and combinations of ceramics, carbides, metals, composites, and plastics available in powder, wire, or rod form. Thermal spray coatings are used to improve the overall performance characteristics and extend the service life of industrial components, and also help meet design requirements for original equipment manufacturers. The number of applications for the thermal spray processes is rapidly increasing, and the coatings are widely used in over 46 industries including the aircraft, aerospace, chemical, electronics, and transportation industries for many, varied applications.



NTST Research and Development

Nevada Thermal Spray Technologies (NTST, formerly Vartech, Inc.) of Las Vegas, NV is a technology transfer spin-off company of the Idaho National Laboratory (INL) that specializes in thermal spray technology. The company conducts thermal spray R&D and production spraying for industry, government, university, and private concerns. The NTST facility is currently equipped with state-of-the-art thermal spray combustion, plasma, and arc systems and the corresponding peripheral facility equipment.

Prior and current NTST R&D customers involve many industrial companies and government agencies including: Abengoa Solar, American Seals West, Army Core of Engineers, Argonne National Lab, Ballistic Missile Defense Organization, Bechtel, DARPA, EG&G Idaho, Idaho National Lab (INL), Kelly Air Force Base, Lockheed Idaho, Lawrence Livermore Lab, National Center for Manufacturing Sciences, National Science Foundation, Praxair, Savannah River Lab, and West Pharmaceutical.

A technical basis is utilized at NTST to optimize the thermal spray processes to produce improved thermal sprayed coatings. This research methodology involves modifications to equipment, process parameters, and powder processing techniques to obtain optimum coatings.

NTST services involve large and small quantity production, materials engineering (e.g. parametric testing), coating research and development, applications development, materials characterization and evaluation, process evaluation, turnkey coating process development, technical consultation regarding product utilization, computational studies, and coating characterization and performance evaluation. Process evaluation is the basis of the work scope that can involve parametric testing, coating characterization, computational studies, and performance evaluation.

Due to the complexity of the thermal spray processes, services are offered in the fields of gas dynamics, coatings, materials, heat transfer, fluid flow, thermal-hydraulics, nuclear technology, and thermochemistry. R&D has been actively pursued by NTST personnel for dual usage in several industries. These coating systems serve as the basis for the NTST product portfolio.

Statistically Designed Experimentation

In most of the NTST R&D work, Statistically Designed Experimentation (SDE) methodologies are used. SDE (e.g. Box, Taguchi, SDE) is an efficient means of determining process factor effects on measured attributes. Using this methodology, processing parameters can be adjusted, optimized, and confirmed, and a realistic specification can be made for the required application. NTST can customize the microstructure of unique coatings for specific applications using this approach. Experiments are conducted using various statistical designs (e.g. factorial, fractional-factorial, central composite) using software such as Design-Ease, Design-Expert, Minitab, and Taguchi. Operating parameters are varied around typical spray parameters using the systematic SDE in or-

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Research & Development

order to display the range of processing conditions and their effect on the coating properties. Regression analysis then determines the effect of any specific parameter on coating property. Properties such as coating roughness, hardness, porosity, deposition efficiency, phase content, and microstructure are correlated to operating parameters and optimized.

Analytical Modeling of the Thermal Spray Processes:

To enhance usage of the thermal spray processes, a better physical understanding of the processes is required. This involves a synergistic mix of analytical and experimental studies. Better understanding of coating formation leads to the development of optimum thermal spray coatings for future industrial applications.

NTST computational services are offered in the fields of gas dynamics, particle dynamics, coating formation, materials technology, heat transfer, fluid flow, thermal-hydraulics, and thermochemistry. NTST maintains a database of computer programs for statistics, plasma physics, particle dynamics, coating dynamics, and chemistry for use in design and analysis.

Gas dynamics is first numerically modeled for the thermal spray gun. This information is then used as a boundary condition to solve the gas dynamics and material interaction problem. The predicted temperature and velocity of the droplets at the spray distance are then used as initial conditions to the coating dynamics code. Multiple polynomial regression analysis is then used to establish the sequential relationship between the process parameters (e.g. power, flow), the coating properties (i.e. porosity, oxides), and the coating mechanical performance properties (e.g. tensile strength, hardness). The equations derived from the regression analysis can then be used to construct a predictor code for the process. Predicted coating properties can exhibit excellent correlation with the actual properties obtained from the experimental studies. NTST has demonstrated this methodology for developing relationships between thermal spray process parameters, coating properties, and coating performance (i.e. a parameter-property-performance relationship).

Characterization and Performance Evaluation

Since NTST is a spinoff of the Idaho National Laboratory it retains access to the equipment and personnel at the lab through a user's agreement. Most recently, the INL characterized the B4C coatings developed by NTST. The INL equipment, facilities, and resources available to NTST include:

Materials characterization: x-ray diffraction, scanning transmission electron microscope, scanning electron microscope, Auger electron microscopy with ESCA, mechanical-thermal resistance heating system (Gleeble), fatigue, creep, and tensile/compression, flexure and toughness, heat treating, oxidation, optical microscopy lab, gas analysis, ultrasonic microscopy, graphite and other furnace, facilities, Thermal analysis (DTA, DSC, DTG), automated ultrasonic NDE.

Powder and materials processing: atomization, inert handling & encapsulation, hot isostatic pressing, explosive consolidation, hot press, cold isostatic press, crusher/grinders, sizing screens, flotation cells, classifiers

Corrosion testing: high temperature, high pressure autoclaves, environmental chamber, heat treating furnaces, electrochemical equipment

Chemical analysis: inductively coupled plasma spectrometer, atomic absorption spectrometer with graphite furnace, UV spectrometers, Fourier Transform IR spectrometer, high resolution gas chromatograph/mass spectrometer, gas chromatographs, high pressure liquid chromatograph, ion chromatograph, differential scanning calorimeter, thermal gravimetric analyzer.

Significant R&D accomplishments

-The development of new coating systems for applications for Abengoa Solar, American Seals West, Argonne National Lab, DARPA, NSF, and West Pharmaceutical.

-Coating process modifications for the Army Core of Engineers, Lockheed Idaho, and Lawrence Livermore Lab.

-The incorporation of a new WC-Co process for aircraft components at Kelly Air Force Base.

-The development of new coating process parameters for conventional materials for EG&G Idaho, INL, and Praxair for specific applications.

-The development of a new materials process for producing Ti powder for BMDO.

-Verification studies for NCMS for conventional coating materials.