Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Process Design for Reliable High Velocity Thermal Spray Coatings:

An Integrated Approach through Process Maps and Advanced Insitu Characterization

By

Alfredo Valarezo Garcés

The ambitious goal to design repeatable and reproducible coatings with enhanced performance is the driving motivation to implement science based strategies to control thermal spray (TS) processes.

The methodology of Process Maps has been advanced towards this purpose by developing systematically controlled parametric states that interrelate process variables with particle state, stress evolution and properties. In the present study, Process Maps have been utilized to investigate the process window in which a high velocity thermal spray (HVTS) system can produce coatings of desired properties. A Diamond Jet torch spraying Ni-20Cr was chosen to systematically explore the particle energy space (thermal and kinetic energy) and produce coatings with different properties. A relatively small range of variability in property values was found for the system in question. Further investigation was carried out to obtain significantly different particle states in a broader range of flame energy levels by depositing coatings with various types of HVTS systems (high velocity -HV- gas fuel guns, HV liquid fuel guns, and HV plasma gun). A common analysis of melting state (by melting index) and kinetic energy among the different processes explained the significantly larger processing range resulting in higher versatility in properties, microstructures and stress formation mechanisms.

The monitoring of stress development during thermal spraying revealed important differences in coating formation and properties. This principle was investigated further in several materials and process systems. The associated mechanisms of stress relief or stress build-up can be used to evaluate the deposit-substrate system including adhesion/cohesion strength, micro-cracking, peening, etc. An in-depth analysis of stress evolution was carried out to study peening effect (impact induced work hardening) in coatings sprayed with particles at supersonic velocities. Analysis of residual stress profiles when peening effect dominates is also discussed using parallel results from neutron diffraction.

The applied principles to study flame energies, heat and momentum transfer to the particles in-flight, stress evolution and microstructure have shed light to understand deposit formation dynamics and ensuing evolution of the coating properties. Eventually, the attained understanding can lead to design the TS process that would deposit coatings of desired microstructure and properties; with the ultimate goal of maximizing performance of the coating-substrate system.

Date: May 7, 2008
Time: 9:30 am
Place: Old Eng. Bldg. Room 301

Program: Materials Science and Engineering
Dissertation Advisor: Prof. Sanjay Sampath