DEPARTMENT OF MECHANICAL ENGINEERING
Purdue School of Engineering and Technology

IUPUI

SPRING 2004 SEMINAR SERIES

Date: Thursday, May 10, 2004

Time: 11:00 am – 12:00 pm
Room: SL 165

Reception at 10:45 am (cookies and refreshments served)
Everyone is invited

Modeling of Pulsed Detonation Thermal Spraying

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Abstract. Pulsed detonation thermal spraying (PDTS) defines a process in which powdered materials are deposited on a substrate (i.e., material to be coated) utilizing the high-energy concentration and gas velocities associated with detonation. The powder material is accelerated and heated by the carrier gas prior to deposition on the target surface. Upon impact on the target surface, the powder material undergoes elastic/plastic deformation to form platelet-shaped particles that adhere to the surface and form a protective coating layer against wear, corrosion and excessive heat. The PDTS coatings are superior to other coating methods with higher hardness, adhesion and bond strength and lower porosity.

While the process of detonation coating has been fairly well characterized through years of laboratory experience, there is still a need to develop analytical tools for understanding the interaction between controllable process variables (e.g., chemical composition of detonable gas, particle thermal properties and particle size) and characteristics of the resultant thermal coating. The PDTS process is a complex multiphase reactive flow that involves combustion chemistry, shock wave formation and propagation, particle transport and shock interaction with the substrate, particulate phase melting and rapid solidification. The presence of fast chemical reactions, detonation wave dynamics and the associated discontinuities in the fluid properties make this problem numerically challenging.

Computations of PDTS process using a multi-component, two-dimensional transient gaseous detonation model are presented. Detonation wave development, shock wave reflection, detonation wave attenuation are discussed. Computational results also include: the gas-phase velocity, temperature, and pressure profiles, and the temperature, percentage melt and velocity profiles of the solid particles. Other factors affecting the PDTS coatings, such as soot formation and contamination of the particulate phase, Deflagration to Detonation transition, and effects of reactive additives on detonation characteristics are also discussed.

About the Speaker. Dr. Ramadan is Postdoctoral Research Scholar in the Department of Mechanical Engineering at the University of Iowa, Iowa City-Iowa, since January 2003, and a Consultant to Praxair Surface Technologies, Indianapolis-Indiana, since June 2003. Before pursuing graduate studies towards a Ph.D. degree at the University of Iowa, he served for several years as a Mechanical Field Engineer, then Office Planning Engineer in the Oil and Gas Industry with an International Construction and Engineering firm based in Athens-GREECE.

He received his Ph.D. degree in Mech. Engrg. from The University of Iowa in December 2002. He earned his M.Sc and B.Sc degrees in Mech. Engrg. from JORDAN in 1989 and 1986 respectively. His research has focused on modeling and computations of pulsed detonation thermal spraying systems. He has published many articles and technical reports on this subject. He is a member of the American Society of Mechanical Engineers (ASME), American Society for Engineering Education (ASEE) and The Combustion Institute.