Nanocomposites and Mechanics Laboratory

Dr. Gobinda Saha's Nanocomposites and Mechanics Laboratory is working in the field of advanced materials design, manufacturing, testing/characterization, and modeling to develop innovative solutions to tackle industrial wear and premature material failure facing structural and non-structural components. The research and development work is currently focused on developing (a) high-strength high pressure cold sprayed coatings and additive manufacturing components based on nanostructured cermet composite materials, (b) smart biocomposites by integrating biofibers with structural glass/carbon fiber-reinforced polymer materials embedded with sensors and/or actuators, and (c) multifunctional materials and coatings by advanced sol-gel processes. The work is fundamentally linked with industry needs."

Included below is a one-page promotional document from Dr. Saha.

High Pressure Cold Spray

A revolutionary spray coating and additive manufacturing method

Cold spraying is a new thermal spraying process used to develop a coating layer by depositing fine, micron-sized particles (reinforced with nanocrystalline ceramic grains) at varying speeds (100 to 1,200 m/sec) onto metallic substrates in the absence of thermal energy. Within the process, the high pressure cold spray (HPCS) is a state-of-the-art technique which utilizes pressure of up to 50 bar (725 psi) with an axial injection of feedstock particles that are heated to a maximum temperature of 1,100^{o}C in the spray gun housing. The high kinetic energy and degree of deformation during the impact on the substrate enable the manufacturing of homogeneous and very dense coatings. HPCS can also be used as an additive manufacturing method.

Coating thicknesses can vary from just a few hundredths of a millimeter up to several centimeters. The high impact speeds of the particles promote rapid spreading, plastic deformation, and the accumulation of a highly dense layer of particles. Bonding between the deposited particles is typically metallurgical, coupled with mechanical interlocking. The absence of high temperature particle heating during the deposition process eliminates oxidation, promotes retention of the properties of the original feedstock particles, induces low residual stresses in the coating, permits the accumulation of thermally sensitive materials such as polymers, and facilitates the deposition of highly dissimilar materials such as cermets.

Benefits

Cold spray applications include both the production and restoration of parts/components in industries such as manufacturing, automotive, aerospace, electronics, petrochemical, biomedical, etc. It can also be used in industrial gas turbines.

Low pressure cold spray (LPCS) coatings have been used to produce dense, well-bonded deposits of many metals and alloys such as aluminum, copper, nickel, tantalum, commercially pure titanium, silver and zinc, as well as stainless steel, nickel-base alloys (Inconel, hastalloy), and bondcoats (MCrAlY). They have been used to produce protective coatings, as well as 3D freeform and near-net shape components. Typical protective coatings produced by LPCS include MCrAlY for high temperature protection and bond coats for thermal barriers, copper-chrome layers for oxidation protection, and corrosion-resistant aluminum and zinc coatings for oil and automotive industries.

Distinguished Research and Innovation Capacity at UNB's Nanocomposites and Mechanics Laboratory (NCM Lab)

Dr. Gobinda Saha is an Associate Professor in the Department of Mechanical Engineering at the University of New Brunswick (UNB), as well as the Director of the Nanocomposites and Mechanics Lab. His research and development work in nanostructured composite materials design and advanced manufacturing at UNB is directly linked with industry partners. Dr. Saha excels in applied research, as demonstrated through two successive industry R&D led positions in Calgary, AB where he developed and commercialized two nanostructured coatings for oil and gas infrastructure. These coatings provided protection from aggressive wear and corrosion using high velocity oxy-fuel (HVOF) techniques. They were superior when compared with industry-standard WC-CoCr microstructured coatings in terms of: (a) enhanced sliding wear resistance (up to 40%), (b) one-third lower erosion-corrosion resistance, and (c) superior bond strength, exceeding 83 MPa (or 12,000 psi).

Distinct features of Dr. Saha's research are: (1) cermet composite design for high-temperature oxidation/erosion protection of components using (2) a low-temperature cold spray condition so as to retain the initial nanocrystalline grain structure in the developed coatings, and (3) using the HPCS as an additive (rapid) manufacturing method.

Commercial Value

There are a few global aerospace parts/engine repair companies who have adopted the LPCS method in their repair and maintenance business. Based on Dr. Saha's work, a pump manufacturing company in Calgary, AB is profiting from the sales of the nanostructured HVOF coatings. Annual revenue is in the millions of dollars.

Based on the market forecast, Dr. Saha is convinced that the development of HPCS and its adoption in the repair business will revolutionize North American spray coating demand.