Workshop : Cold Spray Additive Manufacturing : An innovative technology

FEBRUARY 22 – NRC - Boucherville		
07:45 – 08:10	**Registration and Refreshments**	Greeters
08:10 – 08:30	**Welcome & Opening Remarks**	**Mrs. Milena Sejnoha** Director R&D (NRC); **Dr. Marie-Pierre Ippersiel,** (PRIMA Québec); **To be confirm** (CRSNG)
08:30 – 08:45	**PRIMA QC : Partenaire de vos projets d'innovation** Abstract.	**Cristina Marques** (PRIMA Québec)
09:00 – 09:30	**Introduction to CS today, tomorrow, future** This presentation reviews the basic physical concepts behind cold spray technology, commercially available equipment and diagnostic tools, today's industrial uses, and directions for future application development.	**Dr. Eric Irissou** **Dr. Phuong Vo** (NRC)
09:30 – 09:55	**Manufacturing and Repair Challenges in Small Gas Turbines** Much of the cold spray work being done today industrially is using low temperature materials such as copper, aluminum and zinc, and their alloys. Pratt & Whitney Canada is advancing in these areas, but at the same time working on the challenge of using this technology to produce high quality deposits of high temperature nickel and titanium alloys for additive manufacturing. In partnership with the National Research Council of Canada, P&WC has developed cold spray repair of several small gas turbine components and is making significant progress in thicker 3-D deposits of Ti and Ni alloys.	**Dr. Elvi Dalgaard** (Pratt & Whitney Canada)
09:55 – 10:40	**Coffee Break – 1st Lab tour and live CSAM demonstration – Opportunity for B2B meetings** This lab tour will include live demonstrations to showcase the cold spray technology in different conditions and for different materials. Our technical staff will be available to answer all your questions about hardware and operations.	Lab tour : **Dr. Jean-Gabriel Legoux** **Dr. Manuel Martin** **Dr. Phuong Vo** **Dr. Jean-Michel Lamarre** **Dr. Cristian Cojocaru**

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10:40 – 11:00	**Stainless steel-iron metal-metal composites for biodgradable implant material** Stainless steel and iron powders have been consolidated by cold spray to produce material that can be designed to achieve controlled levels of corrosion through microgalvanic effects, with the aim of application to biodegradable implants, such as stents. The presentation describes the effect of composite composition (i.e. the ratio of Fe to stainless steel) on deposition efficiency, mechanical properties in the as sprayed and annealed conditions and the corrosion behavior.	**Prof. Steve Yue** (McGill University)
11:00 – 11:15	**Cold Sprayed Composite Coatings for Tribological Applications** Metal-matrix composites have a long history for use in tribological applications. Hard phase reinforcements can enhance wear resistance and solid lubricant additions can reduce friction. More recently, with maturity of the process, cold spray has become a technology capable of manufacturing metal-matrix composite coatings. In this presentation, an overview of research on two coating systems will be presented – Al-Al2O3 and Ni-WC. In both cases, the addition of the secondary phase provided an enhancement to the tribological performance compared to the pure metal. These improvements were explained by examination of the "third bodies" – materials generated through the wear process that contribute significantly to the behavior of the tribosystem. For both coating systems, a hard '"tribolayer" formed on the surface due to wear that had better mechanical properties than that of the bulk coating.	**Prof. Richard R. Chromik** (McGill University)
11:15 – 11:30	**Numerical modeling of cold spray processes: Effect of substrate location and shape** Three-dimensional modeling of Cold Gas Dynamic Spray system will be presented. It is found that the stagnation pressure alternates for different substrate standoff distances due to the nature of the supersonic flow interaction with the substrate. One can find the optimum substrate location for any given operating condition, which results in minimum pressure buildup on the substrate. The three-dimensional analysis sheds more light on the complex gas and particle flow fields when cold spray is used for additive manufacturing. In addition, the three-dimensional model allows us to further investigate the effect of practical substrate shapes (such as convex and concave) on the flow field and consequently to determine the optimum conditions to deposit coating particles.	**Prof. Ali Dolatabadi** (Concordia University)

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11:30 – 11:45	**Self-lubricating metal matrix composite coatings fabricated by cold spray: Cu-MoS2 and Cu-MoS2-WC** In the present work, self-lubricating metal matrix composites Cu-MoS2 and Cu-MoS2-WC were fabricated by cold spray. To pursue an ideal spraying condition, how MoS2 and Cu behaved for cold spray was examined by spraying MoS2 particles only and a mix of Cu and MoS2. It was found deposition efficiency of Cu reduced dramatically due to the presence of MoS2 while MoS2 deposition was improved by co-spraying with Cu. The deposition mechanism of Cu-MoS2 was then extracted and strategies to improve MoS2 deposition were therefore conducted. The composites were then examined in terms of recovery of MoS2 and WC, hardness, and microstructure. Improvement of MoS2 and WC on friction and wear resistance will be presented briefly.	**Dr. Yinyin Zhang and Prof. Richard R. Chromik** (McGill University)
11:45 – 12:00	**Title** Abstract.	**Martin Lavoie** (Canada Makes) **To be confirmn** (Réseau Québec 3D)
12:00 – 13:00	***Lunch break***	
13:00 – 13:15	**Online Characterization Techniques for the Cold Spray Process: challenges & Applications** Selected characterization techniques developed for the cold spray processes will be presented. Challenges will be highlighted. Some applications will be presented.	**Luc Pouliot** (Tecnar Automation)
13:15 – 13:30	**Introduction to Equispheres** Equispheres is a new entrant in the metal powder market. Utilizing a novel and patent-pending process, Equispheres overcomes issues that are inherent in current gas and plasma atomization methods. Equispheres powders are virtually mono-sized, spherical, 'fine'-free and agglomerate-free. In addition, Equispheres powders feature a consistent microstructure, no gas entrapment and excellent flowability which help ensure the consistency, reliability and safety of the Cold Spray process. Equispheres is working with major Aerospace companies to develop and refine the product with the ultimate objective to produce a powder that readily supports structural repair and additive applications. Equispheres and our partners believe that the unique features of our powder will enable Cold Spray users to achieve superior mechanical properties and adhesion bond strength presently unachievable in industry.	**Kevin Nicholds** (Equispheres)

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13:30 – 13:45	**Production of spherical powders using the Tekna process** The performances of metal powder-based additive manufacturing (AM) technologies like cold spray, electron-beam melting (EBM) and selective laser melting (SLM) greatly depend on powder characteristics such as flowability, packing density, particles size distribution and chemical composition. Tekna has developed over the last 26 years a strong expertise in the commercial production of powders perfectly tailored to these applications. Also, Tekna has developed a proprietary classification process specifically for removing ultrafine particles within a powder, allowing thereby the optimization of powder performances for AM processes. Tekna's ICP technology will be briefly described and case studies with Titanium-based powders will be presented.	**Dr. Colin McCracken and Dr. Richard Dolbec** (Tekna Plasma Systems)
13:45 – 14:00	**Polycontrols: The expertise in Integration** A few words about the integration, installation and maintenance solutions offered by Polycontrols in order to allow a smooth transition of Cold Spray applications developed in laboratory to an full scale production environment meeting newest Global Industry 4.0 standards.	**Sylvain Desaulniers** (Polycontrols)
14:00 – 14:15	**Application de la projection plasma à froid dans la fabrication d'électrodes pour la production d'aluminium primaire** Le Québec est le quatrième producteur mondial d'aluminium primaire, avec une production annuelle de 2,7 Mt en 2014. Bien qu'il soit essentiellement produit à partir d'hydroélectricité, la production québécoise d'aluminium constitue une importante source de gaz à effet de serre (46% des émissions du secteur en 2012). Ceci est dû au fait que la technologie actuelle utilise des anodes de carbone qui sont consommées durant l'électrolyse de l'aluminium pour former du CO2. À ce titre, la solution la plus efficace serait de remplacer les anodes de carbone par des anodes dites inertes qui émettent de l'O2 plutôt que du CO2. Dans cette présentation, nous allons montrer comment la projection plasma à froid peut être utilisée pour préparer des anodes inertes pour l'électrolyse de l'aluminium et discuter des étapes à franchir pour implanter celles-ci dans l'industrie.	**Prof. Daniel Guay** (INRS)

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14:15 – 14:30	**Cold spray onto carbon fibre reinforced polymer for lightning strike protection** Carbon fibre reinforced polymers (CFRPs) are more and more used in a wide range of industries, but their low electrical conductivity has limited their application. Especially in the aerospace industry, the low conductivity of CFRP used in aircrafts would result in a lightning strike problem. To make the polymer composites electrically conductive, a conductive media must be either embedded into or coated onto the composites. During the past few years, metallization of CFRP has attracted increasing interest, and cold spray is one coating approach to achieve this. In this work, metallic powders were cold sprayed onto the CFRPs used in aircraft by using two different cold spray systems. The coatings as well as the coating/substrate interfaces were characterized and the deposition mechanism onto the CFRP substrate was determined.	**Dr. Hanqing Che** (McGill University)
14:30 – 14:45	***Coffee Break***	
14:45 – 15:05	**Application of Copper Coatings to Used Nuclear Fuel Containers** The Nuclear Waste Management Organization (NWMO) has proposed the concept of a deep geological repository (DGR) for the storage of Canada's used nuclear fuel. A major component of the engineered barrier system is the used fuel container (UFC) comprising a cylindrical shell welded to hemi-spherical heads at either end. An integrally bonded copper coating is applied to the exterior surface of the steel vessel for corrosion protection. Since 2011, the NWMO has conducted a multi-phase development program for the advancement of two copper coating technologies. Electrodeposition will be used to copper coat the factory supplied UFC components and the cold spray process will be used to complete the application of the corrosion barrier to the remaining uncoated zone about the closure weld. The objective of this presentation is to present an overview of NWMO's copper coating development program along with planned future work for continued advancement of the technologies.	**Dr. Jason D. Giallonardo** Nuclear Waste Management Organization (Toronto, Canada)
15:05 – 15:20	**Title** Abstract.	TBA
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15:40 – 16:25	**Coffee Break – 2nd Lab tour and live CSAM demonstration**	Lab tour : **Dr. Jean-Gabriel Legoux** **Dr. Manuel Martin** **Dr. Phuong Vo** **Dr. Jean-Michel Lamarre** **Dr. Cristian Cojocaru**
16:25 – 16:30	**Concluding remarks**	**Dr. Eric Irissou** (NRC)