Preface

Cold spray (CS) is a process in which solid powders are accelerated in a de Laval nozzle toward a substrate. If the impact velocity exceeds a threshold value, particles endure plastic deformation and adhere to the surface. Different materials such as metals, ceramics, composites, and polymers can be deposited using cold spray, creating a wealth of interesting opportunities toward harvesting particular properties. Cold spray is a novel and promising technology to obtain surface coating. It offers several technological advantages over thermal spray since it utilizes kinetic rather than thermal energy for deposition. As a result, tensile residual stresses, oxidation, and undesired chemical reactions can be avoided. Development of new material systems with enhanced properties covering a wide range of required functionalities of surfaces and interfaces, from internal combustion engines to biotechnology, has brought forth new opportunities for the cold spray with a rich variety of material combinations.

The introductory chapter covers the basic principles of cold spray, different apparatuses, and various material systems that have been studied so far. The latter includes metals, ceramics, metal matrix composites, polymers, and nanostructured powders. At the end of the chapter, a critical discussion on the future of this technology is provided.

Chapter 2 describes the experimental procedures that are referred to in the following chapters. Surface treatments, including cold spray coating and shot peening (conventional and severe), are explained. Different experimental techniques including optical and scanning electron microscopy, nano/microhardness measurement, X-ray diffraction measurement of residual stress, roughness measurement, rotating bending fatigue test, coating bond strength and cohesion strength tests and contact angle measurement are discussed in detail.

Chapter 3 presents different approaches to model cold spray process to extend the current understanding of its fundamental principles. In this regard, the following topics are discussed:

1. Assessment of critical and erosion velocities: To reveal the phenomenological characteristic of interface bonding, Lagrangian simulation and occurrence

of adiabatic shear instability, hybrid Lagrangian–analytical approach based on energy calculations, and Eulerian simulation and material jet characteristics are discussed.
2. Mechanical behavior of cold spray coatings: The first finite element scheme to model consolidated coating is proposed. The effect of macroscopic defects such as interparticle boundaries and subsequent splat boundary cracking on mechanical properties is discussed.

Chapter 4 demonstrates the applications of cold spray mainly on repairing damaged parts, additive manufacturing, and corrosion protection in a variety of disciplines, from aerospace to biomedical engineering. This includes a systematic study of defect shape and the ability of cold spray to fill it, fatigue behavior of coatings for structural applications, advantages and challenges of using cold spray as an additive manufacturing process, a novel deposition window at subcritical conditions to obtain porous coatings, and critical assessment of cold spray for corrosion protection.

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http://www.springer.com/978-3-319-29961-7

Powder Consolidation Using Cold Spray
Process Modeling and Emerging Applications
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2017, XVII, 127 p. 52 illus., 20 illus. in color., Softcover
ISBN: 978-3-319-29961-7