coatings

Editorial

Additively Manufactured Coatings

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We are pleased to publish a Special Issue on "Additively Manufactured Coatings" that is intended to provide peer-reviewed articles in the fascinating field of coatings, particularly in the area of additive manufacturing technology.

Functional coatings are of particular importance in the protection of the substrate from chemical and mechanical damage in aggressive environments. They are widely used as cost-effective methods to protect the substrate from wear, corrosion, erosion, tribocorrosion, high temperature, and high pressure in extreme environmental conditions. These are primarily manufactured through metal/ceramic powder deposition in a subsequent layer-by-layer fashion on the substrate materials. In all cases, the functional coatings need to be reliable for the intended application. The emerging additive manufacturing techniques can be utilized to develop high-performance functional coatings. These methods provide geometrical precision, flexibility in geometrical complexity, customization of the coating layers, and reduce the raw material waste, keeping the manufacturing cost low while addressing many of the technical barriers of conventional coating methods. With the rapid development of cutting-edge value-added technologies in the aerospace, nuclear, military, space, and energy industries, additive manufacturing techniques will be major advantages. Novel functional coatings and additive manufacturing techniques will be critical to value-added components in the future development of technologies. The objective of this Special Issue is to include the recent advances in the development of functional coatings utilizing additive manufacturing techniques. This issue provides the latest information and knowledge on the recent developments of coatings utilizing the additive manufactuing techniques that will benefit the professionals from both industries and research and educational organizations with discipline including but not limited to mechanical, manufacturing, materials, aerospace, and chemical. Early career professionals and students will greatly benefit from the Special Issue on advanced coating technologies.

The editors of this issue are from academia while closely working with the industries. From both the industrial and research perspective, the benefits and limitations of additive manufacturing coating technologies are covered in six chapters of this issue. The contributors to this issue are from both academia and industries and possess good experience in coating technologies.

By utilizing additive manufacturing techniques, a sound coating has been produced. Both the solid-state and fusion-based additive manufacturing techniques can be utilized to produce a sound quality coating for various metals and alloys. For example, the cold spray (CS) based technique can produce high-quality titanium (Ti) coating for the magnesium (Mg) alloy substrate to increase its wear and corrosion resistance [1]. Many different coatings, such as Ti, and aluminum (Al), have been developed on AZ31B alloy using the CS technique. The study showed that Ti coating significantly improved the hardness, wear, and corrosion characteristics (in 3.5% wt NaCl solution) of AZ31B compared to the Al coating. The fusion-based AM technique, such as laser powder bed fusion (L-PBF), has been shown as a potential technique to develop the corrosion and tribocorrosion resistant coating on the meal or alloy substrate [2]. In this Special Issue, not only the potential use of the 3D technique for coating is covered, but the basic mechanisms of coating formation are also included. Oyinbo et al. [3] studied the basic mechanism of layer formation in the CS technique using molecular dynamics while considering ductile materials as examples. They showed that due to the jetting phenomena at the particle/substrate interface, materials deform. This can cause a compressive wave formation of ~2.8 GPa at a particle speed of 1000 m/s in the impacted zone. The high-pressure wave is propagating into the substrate and particle from the point of impact leading to the deformation of particle and substrate and heat generation resulting in layer formation. Therefore, the formation of metal layers in CS is given by the new microstructure formation at the particle/substrate interface. Depending on the processing condition, the plasticity at the interfaces will change; so will the coating quality.

In one of the chapters, the quality of the coating in terms of the microstructure and the process parameters using full factorial design in the Laser-based technique is studied [4]. By manipulating the process parameters, the microstructure and, therefore, the wear characteristics of the composite substrate can be tailored. In addition, the thermal stress cycle in the Laser-based cladding process is studied for the nickel coating on steel using a theoretical approach [5]. It is shown that by using the stress analysis, the process parameters can be controlled to achieve the optimum coating conditions [5]. The evolution of the microstructure during the interlayer formation of Ni-based coating is studied in Laser-based technique [6]. He et al. [6] indicated that interlayer cooling has a significant impact on the microstructure and impurity of the interlayer. They showed that the hardness of the interlayer cooling specimens is greater than that of the non-interlayer-cooled specimens.

In the end, we thank all the authors for their valuable contributions. We are confident that you will find this Special Issue of interest to refer to for your learning needs in your coating technology research and applications.

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References

1. Daroonparvar, M.; Kasar, A.K.; Farooq Khan, M.U.L.; Menezes, P.; Kay, C.M.; Misra, M.; Gupta, R.K. Improvement of Wear, Pitting Corrosion Resistance and Repassivation Ability of Mg-Based Alloys Using High Pressure Cold Sprayed (HPCS) Commercially Pure-Titanium Coatings. *Coatings* **2021**, *11*, 57. [CrossRef]
2. Siddaiah, A.; Kasar, A.; Kumar, P.; Akram, J.; Misra, M.; Menezes, P.L. Tribocorrosion Behavior of Inconel 718 Fabricated by Laser Powder Bed Fusion-Based Additive Manufacturing. *Coatings* **2021**, *11*, 195. [CrossRef]
3. Temitope Oyinbo, S.; Jen, T.-C. Molecular Dynamics Simulation of Dislocation Plasticity Mechanism of Nanoscale Ductile Materials in the Cold Gas Dynamic Spray Process. *Coatings* **2020**, *10*, 1079. [CrossRef]
4. Huang, X.; Liu, C.; Zhang, H.; Chen, C.; Lian, G.; Jiang, J.; Feng, M.; Zhou, M. Microstructure Control and Friction Behavior Prediction of Laser Cladding Ni35A+TiC Composite Coatings. *Coatings* **2020**, *10*, 774. [CrossRef]
5. Yao, F.; Fang, L. Thermal Stress Cycle Simulation in Laser Cladding Process of Ni-Based Coating on H13 Steel. *Coatings* **2021**, *11*, 203. [CrossRef]
6. He, Y.; Liu, Y.; Yang, J.; Xie, F.; Huang, W.; Zhu, Z.; Cheng, J.; Shi, J. Effect of Interlayer Cooling on the Preparation of Ni-Based Coatings on Ductile Iron. *Coatings* **2020**, *10*, 544. [CrossRef]