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Editorial

Recent Advances in Metal, Ceramic, and Metal–Ceramic Composite Films/Coatings

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Citation: Norek, M. Recent Advances in Metal, Ceramic, and Metal–Ceramic Composite Films/Coatings. *Coatings* **2022**, *12*, 571. https://doi.org/10.3390/coatings12050571

Received: 19 April 2022
Accepted: 20 April 2022
Published: 22 April 2022

Coating materials and technologies are becoming increasingly important in many research areas because they can provide an efficient and affordable way to engineer materials with desirable properties for a broad range of applications. Depending on the method used, coatings can induce significant structural and microstructural changes in a given material. However, systematic research is necessary to fully understand these changes for a more rational design of a material with desirable properties. The range of properties that can be tailored include mechanical (e.g., hardness, fatigue limit, elongation, tensile strength), thermal (e.g., thermal conductivity, thermal expansion), electrical (e.g., electrical conductivity, dielectric strength), and many other functional properties, including corrosion resistance, hydrophobicity, wettability, optical properties, etc. This Special Issue gathers those studies that show the great potential of a diverse range of metal, ceramic, and metal–ceramic composite coatings for use in materials engineering.

The wear resistance of cold work die steel was significantly improved after the application of high-velocity, oxygen-fuel (HVOF)-sprayed WC-CoCr coatings, irrespective of the test temperature. This better sliding wear behavior was ascribed to the presence of nanocrystalline grains and the fcc-Co phase in the coating [1]. The high-temperature fatigue (at 900 °C) and creep performance of a MAR 247 nickel-based superalloy was also improved after an aluminide coating with the use of the chemical vapor deposition (CVD) process [2]. Two types of Zn-Al-Mg/ZnO composite coatings were deposited on a Q235 metallic substrate by the cold-spray technique in the study of [3]. After the coating was applied, the base material demonstrated better friction, wear, and corrosion resistance. Additionally, photocatalytic properties of the coated substrate were studied and showed a better photocatalytic efficiency in terms of the methyl blue degradation compared to that of the uncoated Q235.

The investigation of various conditions of coating preparation and performance is very important with respect to their subsequent exploitation or reparation in aggressive environmental conditions, such as underwater conditions. The abrasive wear resistance of coatings manufactured by a wet welding method was investigated and compared with those produced in air. In general, the results showed that the former method could be successfully used for marine and offshore structures repair in underwater conditions without the necessity of dragging those elements to the surface of the water [4]. The study of [5] demonstrated the high significance of the surface analysis methods used to study corroded coatings formed on the iron anchors unearthed from the Gudu ruins for the restoration of cultural relics. Based on the research a strategy to repair and to prevent the iron anchors from further corrosive degradation in the humid exhibition environment was proposed.

The plasma electrolytic oxidation (PEO) is an electrochemical and environmentally friendly method to generate thick and dense oxide coatings on metals. The properties of coatings can be easily tailored by changing processing parameters, such as polarization voltage or anodization time in a wide range of electrolytes. Two comprehensive reviews concerning the growth mechanism, microstructure, chemical composition, and various functional and application aspects of ceramic coatings prepared on zirconium (Zr) and Zr alloy substrates by the PEO technique are presented in this Special Issue [6,7]. Due to their unique properties, including remarkable biocompatibility, bioactivity, corrosion and wear resistance, and photoluminescence performance, ceramic coatings can be applied in medicine (dental or percutaneous implants), photocatalysis (water splitting), or nuclear industries (fuel tubes and coolant channel material). The excellent photoluminescence (PL) properties of the Ce^{3+}/Eu^{2+} doped Al_2O_3 coating produced by the PEO of aluminum were demonstrated in the study of [8]. The PL could be modulated by changing the concentration of Eu_2O_3 and CeO_2 particles in the electrolyte which, in turn, induced changes in the $Ce^{3+} \rightarrow Eu^{2+}$ energy transfer.

The anodization of aluminum results in a formation of porous anodic alumina (AAO), which is a well-known template used in various fields of nanotechnology. The AAO was used as a porous ceramic support for ultra-thin Zn-S layers to study their structural and chemical composition by standard infrared (IR) spectroscopy [9]. Due to the well-developed surface of the AAO, it was possible to precisely determine the structure of a Zn-S layer as thin as 20 nm, which was "invisible" to IR spectroscopy when deposited on a flat Si substrate. The study of the Al dissolution rate in various acids and solutions in the absence of anodic polarization sheds new light on the processes occurring during the nucleation and growth of AAO [10].

The guest editor would like to express her gratitude to all authors who have contributed to this Special Issue. Many thanks are also due to the reviewers for a constructive evaluation of the manuscripts and to the publisher for kind and efficient cooperation. It is my pleasure to introduce the collected articles for all potential readers who are interested in better understanding these selected phenomena induced by metal, ceramic, and metal–ceramic coatings produced by a broad range of technologies.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are available from the corresponding author upon request.

Conflicts of Interest: The author declares no conflict of interest.

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