Editorial

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In this second combined issue (issue 2–3) of 2021, we offer a leading Invited Feature Article and eight original technical contributions on topics related to surfaces and coatings.

Lithium-ion batteries are known from their rechargeable performance and are commonly used in portable electronics and electric vehicles, including vehicles used in aerospace exploration and military missions. In the Invited Feature Article,¹ the members of the Russian Academy of Sciences, Dr Andrey Yaroslavtsev and Dr Irian Stenina, review experimental and theoretical research on designing high-performance carbon-coated electrodes for lithium-ion batteries. Carbon nanomaterials and formulated advanced carbon-based nanocomposites provide higher stability to electrodes, slowing down the destruction of high-capacity anode materials and enhancing transfer of ions and electrons. This review provides a nice summary of progress on composites with one- and two-dimensional carbon nanostructures that can inspire research on applications of carbon-based coatings beyond battery electrode materials.

The research team led by Professor Michael Nosonovsky from the University of Wisconsin (WI, USA) studied the wetting properties of cast iron surfaces, particularly suited for pipe flow transportation of water, using machine-learning methods.² The authors use a linear regression analysis, artificial neural network model and multivariate polynomial regression analysis to predict water contact angles as a function of droplet volume, surface roughness and surface chemistry. As expected, they found that the water droplet size was insignificant, while surface physical and chemical characteristics influenced the water contact angle. The surface roughness, which was represented in this study by the grit size of the emery paper, was the most important predictor of the contact angle. The authors show that, for this particular case, a standard machine-learning algorithm can reasonably predict experimental observations of wetting.

High-entropy alloys were discovered just several years ago, in 2004, and therefore they are highly investigated metallic materials. Although many high-entropy alloys have been cast, limited research is devoted to the technologies for engineering such alloys. In two original articles, Professors Peter Rusinov and Zhesfina Blednova from the Kuban State Technological University in Krasnodar, Russian Federation, reveal a novel single-cycle technology of preparation of the high-entropy alloy coatings made of CoCuTiZrHf and deposited on steel. The inventors sprayed mechanically activated CoCuTiZrHf powder on steel using high-velocity oxygen-fuel coating technology in a protective atmosphere, with subsequent heat

treatment of the coating.^{3,4} The authors also describe their investigations into structural parameters of the alloy formulated, their mechanical and functional properties including reversible deformations, phase transformation temperatures and reactive stresses. The friction-wear tests of steel surface-modified by CoCuTiZrHf alloy with thermoelastic martensitic transformations are presented, which showed a decrease in the wear rate of the steel base due to the CoCuTiZrHf alloy coating. The articles are testimonial contributions to the science of high-entropy alloys and coatings with the phenomenon of structure transformation. They also contribute to the development of technologies for producing highly entropic alloys with manipulation of their microstructure.

In another original contribution, Ma *et al.*⁵ report the synthesis of a heterojunction structure made of m-BiVO₄/ZnFe₂O₄ composites by using sol–gel auto-combustion combined with calcination. The as-prepared heterojunction exhibits an enhanced visible-light photocatalytic activity in the conventional degradation of methylene orange. Driven by experimental data, the authors propose the photocatalytic mechanism of degradation based on the formation of reactive species that oxidize methylene orange into carbon dioxide and water.

The computational methods of quantum chemistry have recently gained considerable interest in studies of interactions at the atomic level, outcomes of which can be used in designing new materials and systems, often leading toward technological innovations. In an interesting contribution, the international team of theoreticians from China and Australia demonstrates the use of density functional theory to study the adsorption of perfluorooctane sulfate (PFOS) as well as heptafluorobutyric acid, phenanthrene, phenol and perfluorooctanoate on surfaces of pristine and fluorinated graphene.⁶ This theoretical work was inspired by a possibility of using graphene in the fields of the PFOS detection and capture. The authors found that PFOS adsorption on fluorinated graphene is sensitive to the degree of fluorination. Contrarily, the adsorption of other organic molecules selected in this study was found to be insensitive to the fluorination degree. Although earlier literature reports provide results of experimentation on the fluorination degree regulation of graphene, theoretical studies on this topic are rare and this contribution should attract attention of researchers working on graphene and those combating toxic pollutants.

The next two original research articles describe the use of silver in fabricating antibacterial surfaces. First, Tian *et al.*⁷ describe

formulation of a membrane made of porous polyvinylidene difluoride (PVDF) fibers with incorporated silver chloride (AgCl) using electrospinning technology. Silver chloride in the nanoporous polymeric fibers is then reduced to a metallic silver using a light irradiation. The authors show that such prepared fibrous membranes exhibit antifouling and antibacterial properties and are capable of photodegrading methyl orange. The attractiveness of this technology for producing antifouling and antibacterial fibers is in its simplicity, which should be adaptable to processing of other types of polymers as well. In the second contribution on the use of silver nanoparticles, Li *et al.*⁸ describe layer-by-layer spray deposition technology to cover the additive-manufactured medical-grade Ti6Al4V alloy, a commonly used metal for orthopedic and dental implants, with silver nanoparticles using in-situ Tollen's synthesis. The antibacterial activity of the deposited ~200 nm silver particles was investigated against *Staphylococcus aureus* and *Escherichia coli* bacteria. The topic of antibacterial activity of silver nanoparticles is widely reported; however, the authors propose an original reactive spray deposition method by synthesizing nanoparticles on the surface during deposition.

Tantalum has also found applications in the medical field due to its high mechanical strength, good processability and good corrosion resistance. However, contrary to Ti6Al4V, this metal lacks biological activity and cannot induce bone tissue growth. In the final contribution to this issue, Zhao *et al.*⁹ show that biological activity of tantalum can be improved by introducing a silicon-containing oxide coating. They take advantage of microarc oxidation technology and produce a dense inner layer covered with a porous top surface. As the authors report, the formulated coating has no obvious cytotoxicity and promotes the proliferation of MG63 cells and stretch of actin filaments.

We hope that you will find the content of this issue interesting and inspiring in your research endeavors. As always, we appreciate your comments and suggestions, and wait for submissions of your cutting-edge research results, innovations and discoveries.

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