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Editorial

Featured Papers in Inorganic Materials 2024

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1. Introduction

After the impressive success of the Special Issue "10th Anniversary of *Inorganics*: Inorganic Materials", published in 2023 [1], the "Inorganic Materials" section launched the Special Issue "Featured Papers in Inorganic Materials 2024" as a complementary Special Issue, with the aim of continuing discussion on the recent advances in the field of functional inorganic materials for a green and sustainable future. In particular, the overarching aim of this Special Issue is to increase the knowledge of new emerging areas where the sustainable use of inorganic materials can play a pivotal role, such as catalysis [2–5], clean energy production and storage [6–9], environmental remediation [10–13], the development of value-added nanomaterials and nanocomposites (eventually from waste) [14–16], recycling [17,18], and biomedicine [19–22].

In particular, this Special Issue is composed of a collection of contributions touching different fundamental aspects strictly related to the storage and delivery of renewable energy (i.e., in particular by exploiting hydrogen as an energy source/carrier), the improvement of environmental clean-up approaches to remediate different contaminated media (e.g., air and liquid phases), and the development of inorganic materials with enhanced optical and thermal properties exploitable in many advanced technological fields (e.g., photovoltaics).

Prior to proceeding with the overview of individual contributions, the Guest Editors would like to thank all the Reviewers who spent their valuable time thoroughly reviewing and improving the quality of the articles published in this volume. Moreover, the Guest Editors sincerely thank all the Authors for choosing *Inorganics* and, in particular, the "Inorganic Materials" section, as the place to publish their valuable results.

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2. An Overview of the Published Articles

Overall, this Special Issue collected 10 original papers (9 research articles and 1 review) and received more than 13,000 views, thus, paving the way for further editions of this Special Issue. As expressed above, the scope of this collection covers the entire focus area where inorganic materials can play a key role in order to reach a sustainable future, and this is exemplified by the various topics covered by the 10 original papers published in this Special Issue. This section provides a brief overview of the contributions, organizing them into discreet subsections as reported in Table 1, including the following: (i) Storage and delivery of renewable energy: Hydrogen-based technology, (ii) Environmental remediation, and (iii) Development of inorganic materials with enhanced optical and thermal properties.

Table 1. Correlation between subsections and contributions collected in the present Special Issue.

Subsections	Contribution No.	Title
Storage and delivery of renewable energy: Hydrogen-based technology	1	Li, M.; Hu, Y.; Kong, H.; Huang, Q.; Chen, Y.; Yan, Y. A Study on the Volume Expansion of Vanadium-Based Alloy Powders and Compacts During Hydrogen Sorption. *Inorganics* **2024**, *12*, 318. https://doi.org/10.3390/inorganics12120318.
	2	Yang, Q.; Jia, X.; Qin, Z.; Ding, X.; Li, Y. Enhancements in Hydrogen Storage Properties of Magnesium Hydride Supported by Carbon Fiber: Effect of C–H Interactions. *Inorganics* **2024**, *12*, 273. https://doi.org/10.3390/inorganics12110273.
	3	Davis Cortina, M.; Romero de Terreros Aramburu, M.; Neves, A.M.; Hurtado, L.; Jepsen, J.; Ulmer, U. The Integration of Thermal Energy Storage Within Metal Hydride Systems: A Comprehensive Review. *Inorganics* **2024**, *12*, 313. https://doi.org/10.3390/inorganics12120313.
	4	Zhong, J.; Zhang, T.; Tian, J.; Gao, W.; Wang, Y. Nickel Foam-Supported FeP Encapsulated in N, P Co-Doped Carbon Matrix for Efficient Electrocatalytic Hydrogen Evolution. *Inorganics* **2024**, *12*, 291. https://doi.org/10.3390/inorganics12110291.
Environmental remediation	5	Wang, Y.; Yu, H.; Wang, H.; Chen, T. Hierarchically Porous Titanosilicate Hollow Spheres Containing TS-1 Zeolite Precursors for Oxidative Desulfurization. *Inorganics* **2025**, *13*, 37. https://doi.org/10.3390/inorganics13020037
	6	Sriram, G.; Baby, N.; Dhanabalan, K.; Arunpandian, M.; Selvakumar, K.; Sadhasivam, T.; Oh, T.H. Studies of Various Batch Adsorption Parameters for the Removal of Trypan Blue Using Ni-Zn-Bi-Layered Triple Hydroxide and Their Isotherm, Kinetics, and Removal Mechanism. *Inorganics* **2024**, *12*, 296. https://doi.org/10.3390/inorganics12110296.
	7	El Atti, O.; Hot, J.; Fajerweg, K.; Lorber, C.; Lebeau, B.; Ryzhikov, A.; Kahn, M.; Collière, V.; Coppel, Y.; Ratel-Ramond, N.; Ménini, P.; Fau, P. Synthesis of TiO_2/SBA-15 Nanocomposites by Hydrolysis of Organometallic Ti Precursors for Photocatalytic NO Abatement. *Inorganics* **2024**, *12*, 183. https://doi.org/10.3390/inorganics12070183.
Development of inorganic materials with enhanced optical and thermal properties	8	Sassi, S.; Bouich, A.; Hajjaji, A.; Khezami, L.; Bessais, B.; Soucase, B.M. Cu-Doped TiO_2 Thin Films by Spin Coating: Investigation of Structural and Optical Properties. *Inorganics* **2024**, *12*, 188. https://doi.org/10.3390/inorganics12070188.
	9	Gáborová, K.; Hegedüs, M.; Levinský, P.; Mihok, F.; Matvija, M.; Knížek, K.; Milkovič, O.; Vatraľová, D.; Hejtmánek, J.; Saksl, K. Thermoelectric Characteristics of β-Ag_2Se_{1+x} Prepared via a Combined Rapid Mechano-Thermal Approach. *Inorganics* **2024**, *12*, 334. https://doi.org/10.3390/inorganics12120334.
	10	Costa Oliveira, F.d.A.; Galindo, J.; Rodríguez, J.; Cañadas, I.; Cruz Fernandes, J. Thermal Shock Resistance of Commercial Oxide-Bonded Silicon Carbide Reticulated Foams under Concentrated Solar Radiation at PSA: A Feasibility Study. *Inorganics* **2024**, *12*, 246. https://doi.org/10.3390/inorganics12090246.

2.1. Storage and Delivery of Renewable Energy: Hydrogen-Based Technology

To achieve energy independence, a stable supply of clean energy is essential. Hydrogen is an ideal energy carrier and technological solution for energy storage and transportation [23,24]. In this context, metal hydrides are very attractive materials as they can reversibly absorb hydrogen in large quantities under mild conditions, thus, offering a promising energy storage and carrier solution [25,26].

Li et al. (Contribution 1) studied the volume expansion of a V-based alloy (namely, $V_{61}Cr_{24}Ti_{12}Ce_3$, with a body-centered-cubic structure) after performing hydrogenation reactions, thus, testing its potential as a substrate material for the wall of a hydrogen storage tank. To monitor the in-situ volume expansion, the authors designed and constructed an expansion test apparatus. Results indicated an initial maximum reversible capacity of the V-based alloy of ca. 2.5 wt.%, with a lattice expansion of ca. 37.8% measured through XRD analysis. A powder bed made with the same V-based alloy showed a volume expansion ratio of 131% during the first hydrogen absorption cycle, and 40–45% in the following four cycles, whereas a compact bed, made of the V-alloy powders, organic silicone gel

(PDMS), and graphite flakes, showed a significantly smaller volume expansion ratio (i.e., 97% during the first cycle and 13% in the following cycles). These improved performances are due to the presence of both PDMS and graphite flakes, which do not affect the overall hydrogen absorption capacity of the V-alloys but speed up the absorption kinetics.

Another interesting technological solution is the one proposed by Yang et al. (Contribution 2), who prepared and studied the hydrogen storage performance of two MgH_2-C fiber-based cloth composites prepared by either dry ball milling or wet impregnation routes, obtaining distinct morphologies (namely, the formation of MgH_2 particles uniformly distributed on the surface of the C fibers in the direction of the long axis of the fibers, or the formation of MgH_2 particles diffusely distributed without any distinct aggregation phenomenon, respectively). Both composites show reduced preparation costs, and significantly improved kinetics compared to the bare MgH_2. The experimental results revealed that the occurrence of C-H bonding interactions involving the C fibers is responsible for the enhanced hydrogen absorption/desorption ability of the two composites.

Davis Cortina et al. (Contribution 3) reviewed the recent literature regarding metal hydride materials for hydrogen storage, focusing on their thermophysical, thermodynamic, and kinetic properties. Additionally, since thermal energy storage systems provide a means to enhance the energy efficiency and cost-effectiveness of metal hydride-based storage by effectively coupling thermal management with hydrogen storage processes, authors also explored thermal energy storage materials with particular attention to those that operate at temperatures compatible with the most widely studied metal hydride systems.

As previously noted in this introduction, hydrogen energy stands out with respect to other renewable energy sources due to its high energy density and clean, pollution-free characteristics. In this context, electrochemical water splitting to produce hydrogen using abundant non-noble metals as catalysts has become a research hotspot [27,28].

Zhong et al. (Contribution 4) reported the synthesis of metal–organic framework-derived N/P co-doped carbon-encapsulated FeP nanoparticles onto a nickel foam substrate and successfully tested these systems as catalysts for the hydrogen evolution reaction. The proposed substrates showed excellent activity in both acid (0.5 M H_2SO_4) and alkaline (1.0 M KOH) environments and stability with negligible decay over 48 h.

2.2. Environmental Remediation

During the combustion of gasoline and diesel, sulfur impurities produce sulfur oxides, which are harmful for the environment, thus, performing a preliminary oxidative desulfurization (ODS) treatment emerges as a very important reaction step [29]. In this context, Wang et al. (Contribution 5) investigated the synthesis of hierarchically porous titanosilicate hollow spheres from TS-1 zeolite precursor to obtain catalysts with uniformly incorporated tetrahedrally coordinated Ti sites. The synthesized materials demonstrated remarkable catalytic performance in ODS, achieving complete dibenzothiophene removal within 15 min and a high turnover frequency of up to 123 h^{-1} at 30 °C. This outstanding catalytic performance can be attributed to the tetrahedral coordination Ti of TS-1 sub-units and the hierarchically porous hollow structure of the material itself.

Furthermore, the need to remediate the water, air, and soil pollution caused by human activities has become urgent for society, not only from an environmental viewpoint, but also when considering the effects that environmental contaminants have on human health [30].

Hence, Sriram et al. (Contribution 6) synthesized a Ni-Zn-Bi-layered triple hydroxide via co-precipitation techniques and successfully tested this substrate for the removal of the dye Trypan blue from water via an adsorption mechanism. Adsorption tests indicate a maximum removal effectiveness of around 96.7% at natural pH (ca. 4.5–5.0), with maximum adsorption capacity of 5.3 $mg \cdot g^{-1}$ at dye concentrations ranging from 5 to 30 $mg \cdot L^{-1}$.

Interestingly, when combined with various anionic dye mixtures, selectivity studies showed a high selectivity for the removal of Trypan blue and the removal of other cationic dyes. Recyclability investigations revealed the notable removal of Trypan blue using 0.1 M NaOH for the desorption.

Lastly, El Atti et al. (Contribution 7) reported the synthesis of a TiO_2/mesoporous silica SBA-15 nanocomposite using an organometallic decoration method (based on Ti(III) amidinate) and compared it with an analogous system prepared via a Ti(IV) precursor. Photocatalytic performances of these two different nanocomposites were investigated for the abatement of NO under UV light irradiation in humidified air. Interestingly, the TiO_2/mesoporous silica SBA-15 nanocomposite prepared from the Ti(III) precursor demonstrated an NO abatement performance 40% more efficient than the reference photocatalyst TiO_2 P-25.

2.3. Development of Inorganic Materials with Enhanced Optical and Thermal Properties

Sassi et al. (Contribution 8) reported the synthesis of Cu-doped TiO_2 films (with Cu concentration in the 0–8% range) grown directly on FTO glass by means of a spin coating deposition. Morphological and structural characterization revealed the occurrence of small, spherical nanoparticles with a preferred TiO_2 anatase (101) orientation for all samples. Regarding the optical properties, the 2–4% Cu-doped sample showed high transmittance, thus, making these systems promising candidates for electron transport and potentially integrable in perovskite solar cells.

Gáborová et al. (Contribution 9) investigated the thermoelectric properties of Se-rich β-Ag_2Se synthesized via a solvent-free mechanochemical method followed by spark plasma sintering step. Importantly, single-phase Ag_2Se_{1+x} samples with varying Se content were produced. The increase in Se significantly influenced the material's thermoelectric performance, and the sample with nominal composition $Ag_2Se_{1.01}$ exhibited a high figure-of-merit ZT > 0.9 at ca. 111 °C, which is nearly six times higher than the reference sample (β-Ag_2Se).

Lastly, Costa Oliveira et al. (Contribution 10) investigated the thermal shock behavior of commercial oxide-bonded silicon carbide (ob-SiC) reticulated porous ceramic (RPC) foams, potentially exploitable as volumetric ceramic receivers for solar thermal electricity production. Foams were subjected to well-controlled temperature cycles (in the 800 to 1400 °C range), and the damage induced by thermal shock was quantified by performing crush tests. Results indicated that damage was critically dependent on both the bulk density and cell size. Interestingly, better thermal shock resistance was achieved by decreasing both the bulk density and cell size.

3. Conclusions

With this Special Issue "Featured Papers in Inorganic Materials 2024" published in the "Inorganics Materials" section and also published as a book, the Editors hope that the high quality of the contributions collected here will receive the visibility and attention they deserve. These would help readers increase their knowledge in the field of inorganic materials, and be a new source of inspiration for novel, focused investigations.

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