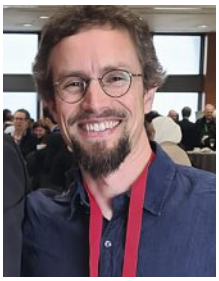
Editorial

Prof. Maksym V. Kovalenko



Dr. Simon C. Boehme

"Materials Chemistry is the scientific discipline that designs, synthesizes, and characterizes materials with particular interest on both their processing and the understanding of useful or potentially useful properties displayed by the materials designed and synthesized for specific applications". Such is the latest, published recommended definition of Materials Chemistry by the International Union of Pure and Applied Chemistry.[1] This definition is the result of the initial work of the IUPAC task group – P. Day, L. V. Interrante, and A. R. West,[2] followed by discussions and natural evolution of the field. Materials Chemistry thus encompasses the utmost broad cohort of amorphous-to-crystalline materials ranging from organic polymers to inorganic solids, captures ever-expanding methods of molecular and solid-state chemistry for their synthesis and characterization, and relates to the myriad of the resulting functionalities and properties.

In January 2024, responding to the needs of the evolving materials community of Switzerland, the SCS established a new *SCS Division of Materials Chemistry* (MatChem)[3] by amalgamating the former SCS division for Polymers, Colloids, and Interfaces and other scientists identifying themselves as 'material chemists'. Serving as a new home for a broader range of scientists, MatChem aims to embrace the inherent diversity of materials chemistry and to offer a platform for networking and exchange of ideas, including with their international *vis-à-vis*. In particular, MatChem organizes symposia, seminars, and advanced training courses. This special issue, '*Materials Chemistry*', provides a glimpse into the breadth of research activities by the vibrant research community, spanning soft materials, materials discovery, energy-storing materials, and nanostructures.

T. Abitbol (EPFL), ***E. W. Appenzeller*** (ProSeed Co-Founder), and their colleagues highlight innovative approaches to upcycling wet byproducts from the food and beverage industries into nutritious food materials, emphasizing sustainability and circularity. It presents two case studies. The first explores the transformation of okara, a tofu and soymilk byproduct, into tempeh-like cakes through solid-state fermentation. This method enhances the nutritional profile of okara while mitigating spoilage challenges inherent to its high moisture content. The second case study introduces ProSeed's on-site drying technology, stabilizing brewers' spent grain to create Barley Flakes, precursors for high-protein, high-fiber raw materials in food manufacturing. These examples underscore the potential to reduce waste, enhance resource efficiency, and create new avenues for nutritious food production, addressing global challenges in food sustainability.

D. W. Yee and ***H. Elhaddad*** (EPFL) composed a mini-review on the advancements in stereospecific radical polymerization, a persistent challenge in polymer science due to the inherent stereochemical limitations of radical mechanisms. The authors outline diverse strategies to achieve tacticity control, such as confinement within nanostructures, tailored monomer design, solvent effects, and additives like Lewis acids and hydrogen-bonding agents. Emerging approaches, including electric-field-assisted polymerization, demonstrate significant innovation potential. Highlighting achievements and limitations, the authors emphasize the transformative impact of tacticity control on polymer properties, opening pathways for designing advanced materials with precise structural and functional characteristics.

The article by ***L. Nienhaus*** (Rice University, USA) delves into the impact of intermolecular interactions on photon interconversion processes in solid-state applications, particularly singlet fission and triplet-triplet annihilation upconversion. These processes are pivotal for enhancing solar cell efficiency by addressing thermalization losses or, conversely, by enabling sub-bandgap photon utilization. The author discusses the effects of molecular arrangement, coupling strength, and aggregation. We note that Lea Nienhaus received the SCS Grammaticakis-Neumann Prize 2023 in photochemistry. We refer the reader also to another excellent recent *CHIMIA* article by the same author on photon upconversion.[4]

S. Banerjee (PSI and ETH Zurich) and his team discuss advanced electrochemical strategies for the recovery of lithium from unconventional and dilute sources, addressing the growing demand for this critical element in energy storage applications. They emphasize the potential of direct lithium extraction (DLE) technologies, particularly hybrid capacitive deionization. Key innovations include the use of redox-active insertion hosts like ζ-V_2O_5 and the design of porous electrode architectures to enhance ion capture and release. The study also explores the integration of DLE with renewable energy and resource recovery processes. We note that this article is the first publication of Banerjee as a full professor of battery materials jointly at PSI and ETH Zurich, starting December 1st 2024. We wish him and his team an easy start to their new research endeavors.

F. O. von Rohr (University of Geneva, and SCS Werner Prize winner 2022) examines the evolving landscape of materials discovery, emphasizing the integration of emerging technologies such as artificial intelligence (AI), robotics, and self-driving laboratories. While these innovations promise transformative progress, the author argues for a pragmatic focus on incremental improvements, such as automating routine tasks like sample preparation and data analysis, to address immediate bottlenecks. The author highlights the potential for a national infrastructure, proposing *Swiss Materials Discovery* as a collaborative platform to enhance accessibility to cutting-edge technologies and foster impactful advancements in both academic and industrial materials research.

M. V. Kovalenko and ***D. N. Dirin*** (ETH Zurich) review a decade of progress in colloidal lead halide perovskite quantum dots, a class of materials pioneered by their group. They chiefly focus on the peculiarities of these structurally soft yet electronically well-behaved semiconductors, highlighting key advancements such as ligand engineering. Breakthroughs in scalable manufacturing techniques have paved the way for industrial applications, particularly in display technologies. The review also briefly touches upon the emerging potential in quantum light sources and photocatalysis, emphasizing their unique defect tolerance and electronic properties that set them apart from conventional quantum dots.

M. Yarema (ETH Zurich), **G. *Dmytriv*** and ***V. Pavlyuk*** (the Ivan Franko National University in Lviv, Ukraine) and co-authors focus their narrative on the hydrogen storage systems, which are at the heart of the sustainability transition. The possibility of storing H_2 at high gravimetric capacities remains a formidable challenge. The article highlights intermetallics as superior hydrogen storage media of the future. The authors outlined several strategies for improving the material's properties, including the use of ultralightweight compositions, such as Mg- and Li-based alloys, nanoscale physical dimensions of intermetallics, and carbonaceous composite additives. This contribution, which consolidates the research output of Ukrainian scientists at Lviv University and the recently established start-up company 'Lviv Hydrogen', is a living testament to the resilience of Ukrainian educators and scientists in times of war.

We hope you will enjoy reading this issue and may even opt to be an enthusiastic contributor to the subsequent Materials Chemistry issues!

Prof. Maksym V. Kovalenko (*President MatChem*), Dr. Simon C. Boehme (*Vice-president MatChem*)

[1] https://www.degruyter.com/document/doi/10.1515/pac-2023-0215/html; https://iupac.org/recommendation/definition-of-materials-chemistry/.
[2] P. Day, L. W. Interrante, A. R. West, *Pure Appl. Chem.* **2009**, *81*, 1707, https://doi.org/10.1351/PAC-REP-09-03-02.
[3] J. V. Milic, S. C. Boehme, *CHIMIA*, **2024**, *78*, 165, https://doi.org/10.2533/chimia.2024.165, https://scg.ch/scg-news/ga23 and https://scg.ch/component/pages/page-materials.
[4] C. M. Sullivan, L. Nienhaus, *CHIMIA*, **2024**, *78*, 518, https://www.chimia.ch/chimia/article/view/2024_518/2024_518.

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